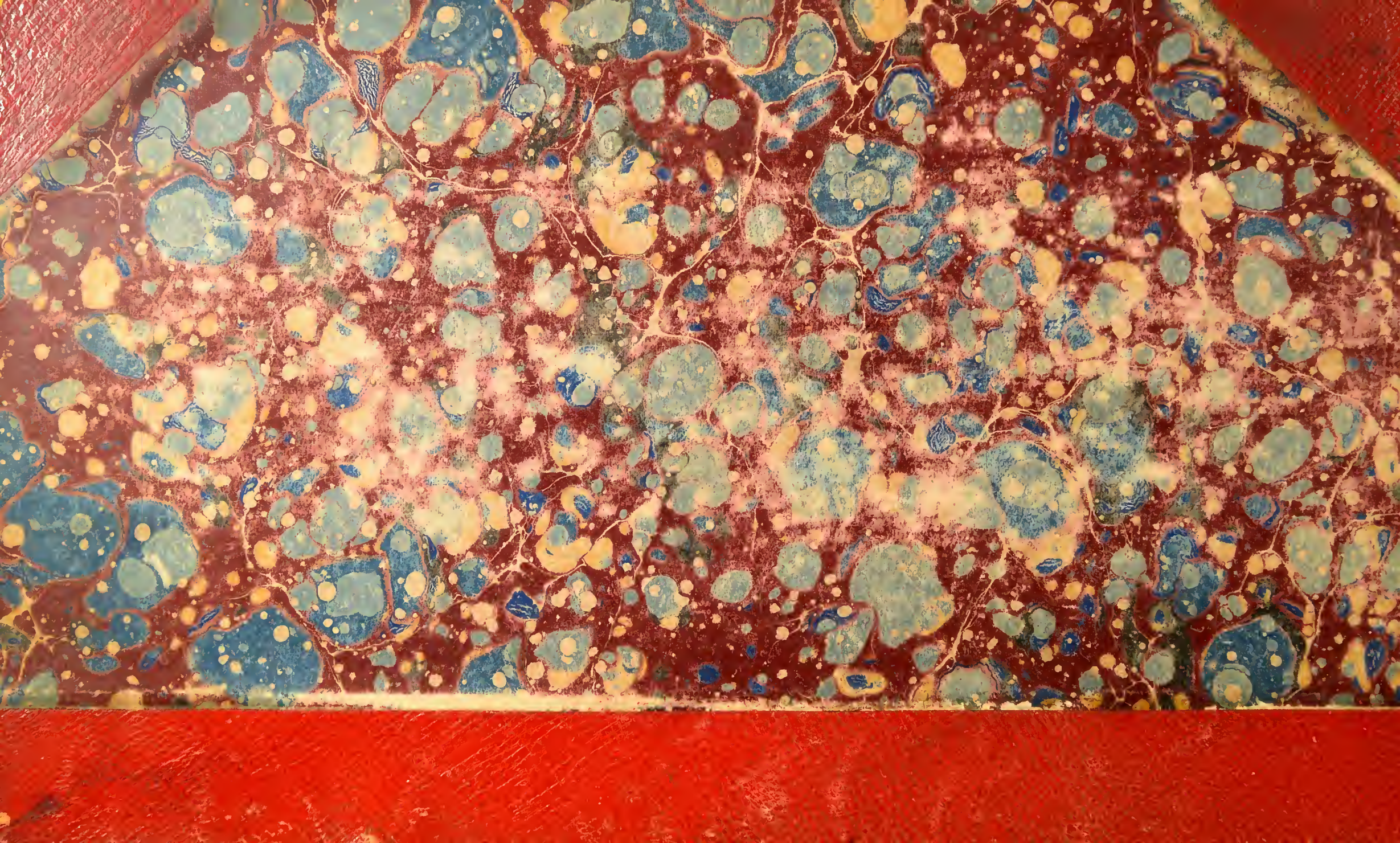

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REPORT

IN RESPECT OF

THE INQUIRY AS TO EFFLUVIUM NUISANCES

ARISING IN CONNEXION WITH VARIOUS

MANUFACTURING AND OTHER BRANCHES OF INDUSTRY.

BY

DR. BALLARD.

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CONTENTS.

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On Effluvium-Nuisances, by Dr. Ballard.

INTRODUCTION.

On April 6, 1875, Mr. Simon, at that time Medical Officer of the Board, brought before the President a proposal that I should be charged with the large inquiry on which the following is my first report,—a general inquiry, namely, which I was to carry on at such times as my other office-engagements would allow, into "the effluvium-"nuisances which arise in connexion with various manufacturing and "other branches of industry, specially with regard to the effect upon "health of each such nuisance, and to the degree in which the nuisance "can be prevented;" and the President having approved this proposal, I thereupon received my instructions from Mr. Simon, and I commenced the inquiry in November 1875. From the nature of the inquiry it has been impracticable to pursue it in any systematic order. It has been necessary to make inquiries, and to visit establishments of the same kind of business, in many different places; and, on the same day, perhaps, to visit various kinds of business establishments in the same place. I am by no means sure that all branches of industry producing effluvium nuisances are included in the report; but I think it will be found that all the most important of them are included. And as respects the remainder, I think it will probably be found that the principles enunciated as respects those industries reported on are applicable *mutatis mutandis* to those which may have been omitted, whether regard be had to the nature of the effluvia and their effect upon public health, or to the means which may be suggested for the abatement or minimizing of the nuisance created. The magnitude and difficulties of the subject were obvious as soon as it was fairly entered upon.

In order to avoid periphrasis I shall throughout this Report designate manufacturing and other branches of industry producing effluvium-nuisances "offensive businesses," and the nuisances they occasion "industrial nuisances."

In pursuing the inquiry I have endeavoured to obtain information upon the following points, viz. :—

1. The extent and degree of the inconvenience to the community occasioned by industrial nuisances.
2. The industrial processes, or the parts of industrial processes, which produce effluvia complained of as offensive.
3. The evidence that these offensive effluvia are also injurious to health.
4. The methods which are in use or may be devised for preventing or minimizing nuisance from them.
5. (Incidentially.) The difficulties experienced by local authorities in dealing with this class of nuisances.

The only observations of a general character I propose making at present are the following. The tendency of the inquiry is to show that,

Extent and degree of public inconvenience.

I. While certain kinds of offensive businesses are to be met with and occasion nuisance mainly in certain known localities, the majority of them are scattered more or less widely over the country, and one or more of them are to be met with usually in every town and in some villages. For various reasons, these nuisances are not always made the subject of complaint to local authorities, even where the nuisances are pretty constant, but the annoyances, and sometimes serious annoyances, exist nevertheless. I soon discovered that the frequency of complaints made to the local authorities was no trustworthy criterion of the extent or intensity of a nuisance. Several causes conduce to this. In the first place there is the thoroughly English and praiseworthy disinclination to be unneighbourly. English people living in the same town or village will bear a great deal of annoyance from those with whom they live in amity before they complain to any constituted authority, especially if they think that such complaint will lead to legal proceedings in which they are likely to be called to give evidence. This feeling operates decidedly more in small towns and villages, where the inhabitants are much thrown together socially, than in large towns or in London. In the second place it sometimes happens that the person whose trade creates the nuisance is the principal and most important man in the place, and abstention from complaint results from a dread of his influence being exerted adversely to the complainant. Allied to this last is a third cause. It sometimes happens that the persons most annoyed are those who are either directly or indirectly dependent for their livelihood upon the existence of the establishment, or class of establishments, creating the nuisance. Such persons are not at all likely to complain, however great the annoyance they experience. In the fourth place, it sometimes happens, from one cause or another, that persons annoyed by trade effluvia abstain from making complaint.

Complaints to local authorities no trustworthy criterion.

because they are unable distinctly to associate the nuisance they suffer from with a particular establishment. This often occurs where offensive businesses of the same or of different kinds are congregated in or about some particular spot. When they are of the same kind complaint is sometimes made generally of the group of establishments; where they are of different kinds, the persons who would be disposed to complain are not sufficiently informed to be able to distinguish between the different effluvia. Habitual exposure to trade effluvia and constant daily familiarity with them tend, as is the case with all offensive odours, to render people less sensitive to their influence, and thus less disposed to complain of them than they otherwise would be. I have often myself experienced this loss of sensitiveness in the midst of the most offensive trade processes.

Habit, &c. affect sensitiveness to ill odours.

To a similar cause may probably in part be attributed the fact that a nuisance is sometimes less complained of in the immediate vicinity of a trade establishment than at a distance from it, where the effluvia are only occasionally wafted by the wind. It is no criterion of the existence or intensity of a trade nuisance that it is not complained of in the immediate purlieus of an establishment; so it is no valid ground for disbelieving the assertions of those who complain, although living at a distance.

Some individuals, moreover, are more sensitive to offensive odours than others: for personal habits of life and the habitual surroundings of persons in different social positions, while they may cause some to feel distress and inconvenience from comparatively trifling degrees of stench, may render others little observant of comparatively intense offensiveness.

Degree of nuisance varies with nature of trade.

The degree of nuisance occasioned by offensive businesses varies greatly with the nature of the businesses. The most offensive effluvia are those which are given off from trade processes in which the materials used consist mainly of animal matters, especially refuse animal matters, or which contain elements of animal origin. The most disgusting of all are the effluvia from the process of gut-scraping and the preparation of sausage skins and catgut, the preparation of artificial manures from "scutch" (the refuse matter of the manufacture of glue), the manufacture of some other kinds of artificial manures, and the melting of some kinds of fat. Manufacturing businesses which deal with vegetable substances are often very offensive, but only rarely can be said to give rise to disgusting effluvia. Among the most offensive are those in which effluvia are thrown off during the heating of vegetable oils, as for example, during the boiling of linseed oil, the manufacture of palmitic acid from cotton-oil foots or palm oil, the manufacture of some kinds of varnish, the drying of fabrics coated with such varnishes, and the burning of painted articles, such as disused meat tins. Among the trades which deal with materials which are neither animal nor vegetable substances, the most offensive effluvia proceed from the manufacture of ammonium sulphate or chloride, and some other processes and manufactures in which a copious evolution of sulphuretted hydrogen occurs, and from gas making and the distillation of tar. Public attention has of late years been called to the nuisance arising from the manufacture of alkali and bleaching powder. The fumes proceeding from works of this kind are acid and irritating, and to most persons offensive; but the chief complaints about them have relation to the injury they inflict upon vegetation in the neighbourhood of the works. This has been and unquestionably still is, although probably to

On Effluvium-Nuisances, by Dr. Ballard.

a less degree than formerly, severe. I do not find that persons who have no property to be injured by the fumes complain very much of their mere offensiveness. No doubt these fumes are very distressing to persons unaccustomed to an atmosphere in which they are largely diffused (they are distressing to myself), but for most persons custom greatly attenuates the nuisance, so that it is little noticed by persons residing in the towns where such works as these are principally congregated.

Extent and degree of nuisances vary with locality, weather, &c.

Various circumstances of locality and surroundings, wind, weather, &c., modify the extent to which such nuisances spread and their degree. The distance from works giving off offensive effluvia, at which their effluvia are a source of nuisance, varies greatly, from a few yards to several miles. This partly depends upon the nature of the effluvia, partly upon the elevation at which they are discharged into the atmosphere, and the elevation of the surrounding neighbourhood, and partly upon conditions of weather. Thus, effluvia, which consist of vapours of high density and little diffusive capacity do not, as a rule, travel so readily to a distance as those which are less dense and more easy of diffusion, but the very fact of more ready diffusibility attenuates while it extends the nuisance. My own observations induce me to think that the distance at which trade effluvia create nuisance depends very much upon the other conditions I have mentioned. Thus, effluvia discharged near the ground are more likely to produce annoyance in the immediate neighbourhood of works than at a distance from them. On the other hand, when effluvia are discharged at a considerable elevation, their offensiveness is usually scarcely, if at all, perceptible close to the works, but at a greater or less distance from them. Hence it occurs that immediate neighbours may be relieved from annoyance by carrying an offensive vapour into a tall chimney shaft, but often at the expense of persons living at a distance. Again the surroundings of the works may make a difference. Thus, in the open country where there is nothing to impede the free travelling of vapours through the air, their offensiveness may be a source of inconvenience to persons living at the distance of one or more miles, even although the vapours may be discharged at the surface of the ground, or little above it; whereas similar vapours similarly discharged in a town, or in places where their passage through the air is obstructed by buildings or other impediments, may only give offence to persons residing within the limits of these impediments, as, for instance, in the same street with the works or in adjoining streets or courts along which the vapours may have free course. For the same reason it may happen, when the effluvia are discharged from a chimney shaft, that a hill or rising ground at a greater or less distance may intercept their course, and that the offensiveness may be perceived on the side or summit of the hill, and not at its base, nor yet on low ground at a similar distance from the works in another direction. Hence, the height of the chimney from which the discharge takes place will, in places where there is irregularity of the surrounding country, influence considerably the distance and the precise localities in different directions in which the offensiveness is perceived. The amount of moisture in the atmosphere and the direction and force of the wind also modify the distances to which offensive effluvia will travel and indeed the intensity of the offensiveness when it is perceived. When the air is saturated with moisture and there is little or no wind, effluvia hang about the immediate neighbourhood of their point of issue, even when discharged at some elevation; they are entangled in the cloud of moisture, and are carried away by it, should the cloud move on, whithersoever the cloud

proceeds. A London fog is a familiar illustration of this state of things. Then should there be rain, the effluvia are washed down by it to the ground, the more readily the more soluble they are in water. On the other hand, in clear weather when there is little or no excess of moisture in the air, the effluvia will pass readily to a distance, and be perceptible in the direction in which the air is moving. In a still atmosphere, the effluvia if discharged at a low level, hang and diffuse themselves about the works; but if a high elevation from a chimney, rise still higher with the heated volume of air to an elevation where they may meet with a current of air driving them slowly in some particular direction; but they then usually undergo considerable diffusion and attenuation before they arrive at the surface of the ground. A high wind, if boisterous, scatters the effluvia, attenuating them at the same time, a long way in its direction; but if not boisterous, but steady, especially if there be some excess of moisture, the effluvia may be carried in a more or less intense form to very considerable distances.

Atmospheric temperature also has something to do with the offensiveness of trade effluvia. Such of these as proceed from the decomposition of organic matters originate more readily in warm weather than in cold, and hence it is that certain trade processes are more complained of in the summer than in the winter months, such trades for example as fellmongering, gut-spinning, blood albumen making, and the sorting and sifting of domestic refuse. But apart from this, there are certain kinds of odours which are less readily tolerated in hot than in cold weather. A striking example of this is the odour of melted fat such as arises from the places where fat is melted for candle or soap-making. The objection to such an odour in the summer is paralleled by a similar objection by most persons to fatty foods and to ordinary kitchen smells at that season.

Difficulties of a scientific classification of offensive businesses.

II. It is difficult to classify satisfactorily the businesses which give off effluvia creating nuisance. Some are very important manufactures, the staple trades of certain neighbourhoods, involving the sinking of large capital in the business and in plant; others are petty trades carried on, perhaps, in the open air, or on a small scale, and involving little or no expenditure of capital; and there are all grades between these extremes. The materials dealt with may be derived from the mineral, vegetable, or animal kingdom, and in some trades from two or all of these kingdoms. A considerable proportion of the nuisance trades consist in the working up and utilisation of refuse matters often of a mixed nature, domestic refuse, town refuse, and trade refuse, and of various offensive matters which it is important to get rid of from populous places, and which are too valuable to destroy.

The chemical nature of the effluvia again cannot be well used as a basis of classification, since, on the one hand, the effluvia are in many cases of a very composite character, and in many other cases undetermined; while, on the other hand, an attempt to do so would throw into the same group such heterogenous businesses that the classification would be simply pedantic and practically worthless. Equally futile would be the endeavour to classify businesses according to the nature of the injury their effluvia inflict upon persons exposed to them, since, as I shall presently have occasion to show, the injury inflicted by trade effluvia wholly unlike may be very similar or apparently identical, and in any case may vary with accidental circumstances. Lastly, it occurred to me that the practical means of preventing nuisances, or at any rate the principles of dealing with them for the purpose of abatement, might

form a ground of classification; but here again I was met by the fact that in scarcely any business was it possible to lay down any one means or even any one principle applicable to secure this object.

The classification adopted based on convenience.

I fall back, therefore, upon a classification which, although crude, has the advantage of being convenient for the purposes of this Report, and I propose to group offensive businesses as follows, viz. :—

1. The keeping of animals.
2. The slaughtering of animals.
3. Other branches of industry in which animal matters or substances of animal origin are principally dealt with.
4. Branches of industry in which vegetable matters are principally dealt with.
5. Branches of industry in which mineral substances are principally dealt with.
6. Branches of industry in which matters of mixed origin (animal, vegetable, and mineral) are dealt with.

In distributing the offensive businesses of which I shall have to treat between these headings, admittedly unscientific, it may appear to some minds that accuracy has also been occasionally lost sight of, and that industries have been placed in one group which in strictness ought to have been placed in another. For any such apparent offence against order, I again advance the plea of convenience.

One, two, or more processes of a trade may be offensive.

In some offensive businesses the material dealt with undergoes but one process, that process giving rise to offensive effluvia. In others, and these by far the most numerous, the raw material is subjected to varied manipulations before it issues in the article of commerce. It may be that each separate step in the process is liable to give origin to an effluvium nuisance, or it may be that one or two only of the processes are open to this charge, the remainder being wholly inoffensive. And when two or more of the processes are thus of offensive character, it may happen, and usually does happen, that the effluvia given off in the different processes are different, both chemically and to the senses, so that from the same establishment offensive effluvia varying in nature and in degree of offensiveness may issue at the same time or at different times. Moreover, it is to be observed that the same branch of industry or manufacture (looking at its designation and final result), is not always carried on in precisely the same way, nor always with precisely the same materials even, by all the persons engaged in it.

Specialities of detail in a trade affect the question of nuisance.

The general principle of the manufacture may be the same, and its broader features may be the same, but expediency, convenience, or the attainment of some special object (perhaps a speciality of the manufacturer) may lead to variations of detail, and these variations may modify more or less the aspect of the business as viewed in its relation to the subject of this Report. And, more than this, such specialities in methods of working have in some instances rendered my task one of unusual difficulty. They rendered necessary a mastering of details, at first sight perhaps trivial and sometimes unexpected, such as could not have been accomplished had I not received the cordial assistance and co-operation of the manufacturers themselves. I do not pretend even after the prolonged inquiry I have made, to have learned all that might be learned in this respect. Nearly every day that I have been engaged in visiting trade establishments something has come to my knowledge which I did not know before, or something which I did know before

has acquired in my mind a position of importance which I had not previously supposed to be its due. Hence it may happen that a feeling of disappointment may now and then arise in the mind of one referring for information to this Report. He may fail to find the particular piece of information that he needs. He would probably be in no better position were my inquiry still further protracted, not only because new processes are continually being adopted for carrying out new inventions, but because established businesses are constantly liable to modification in the method of conducting them (as for instance, in consequence of the varying value of materials capable of substitution the one for the other), either by the introduction of new methods or by the re-introduction of methods previously abandoned. I have had to content myself with describing processes of established businesses as I have in the course of my inquiry seen them generally pursued, adding, where essential to my object, a description of any peculiarities of process which have appeared to me to be important. Technical descriptions of businesses must always be difficult to one not engaged in the actual businesses, but in respect of several very important manufactures the difficulty which I naturally experienced has been overcome by the kind assistance, readily accorded me, by some of the most distinguished manufacturers, who at my request carefully read through such of the proof sheets as related to their trades, and suggested various corrections and amendments which were essential to accuracy.*

On Effluvium-Nuisances, by Dr. Ballard.

III. It is still more difficult to determine to what extent offensive trade effluvia are to be regarded as injurious to public health. The method to be adopted to settle this point (so far as it is capable of being settled), was the subject of conversation between the late Medical Officer of the Board and myself when the inquiry began. We agreed that any valid statistical investigation was quite impracticable, partly on account of the enormous labour which it would have involved and the consequent protraction of the inquiry to a period altogether undeterminable, but mainly on account of the obstacles, at present insuperable, to eliminating the influence upon health of other circumstances (some known or knowable, others unknown and unknowable), the influence of all of which, however, would have, one by one, to have been eliminated had this method been adopted. It was clear that the only method open to me consisted in such inquiries addressed to individuals as I might have opportunity of making, and in gathering up, and valuing on the spot, the opinions on the subject held by medical men, and especially by medical officers of health.

Are offensive trade effluvia injurious to health?

More than one definition of the term "injurious to health," and more than one criterion of such an influence being in any case exerted, may be suggested.

"Injury to health." What does the term mean?

(*a.*) It may mean that exposure to the offensive effluvia causes bodily discomfort or other functional disturbance continuing or recurring as the exposure continues or recurs, and tending by continuance or repeti-

* Although, on the completion of my Report, I shall have the pleasure of tendering my thanks to those gentlemen by name who have often, at much personal inconvenience I fear, given me generally their assistance in my inquiry, I ought not to defer mentioning those manufacturers who have assisted me in this particular way in respect of the earlier portion of my Report, viz., Mr. Wm. Vickers, bone boiler, size maker, soap manufacturer, and manure manufacturer, of Manchester and Widnes; Mr. Turney, leather manufacturer, of Nottingham; Mr. George Gilligan, tanner, of Reading; Mr. Freeman Wright, glue manufacturer, of Needham Market; Mr. Newland, of Mr. James Duncan's sugar refinery, Victoria Docks; and Mr. McDonald, of Poynter's animal charcoal works, Greenock.

tion to constitute (though, perhaps, not a clearly defined form of disease) an appreciable impairment of general health and strength.

(*b.*) Or it may mean that persons exposed to them are more deeply and more definitely damaged in health; that their lives are shortened, or pursued in chronic ailment; that they are rendered more liable than other persons to the invasion of definite forms of disease; or that diseases are with them apt to run a less favourable course than with other persons.

I am not quite sure that these two definitions, which I have ventured to attempt, do not somewhat overlap one another, since, after all, what we mean when we speak, in common parlance, of an impairment of general health and strength, does really involve definable systemic alterations, say in the blood or nervous system, due often to recognisable antecedent conditions. But for practical purposes they may be allowed to suffice, especially as my meaning may become clearer as I proceed to illustrate it.

(*a.*) Functional disturbance due to impressions made on the senses.

(*a.*) The first definition is applicable to those cases in which functional disturbances unquestionably arise as the result of the impression made by offensive effluvia upon the senses. Persons in the best of health may suffer such disturbances from very brief or temporary exposure, the amount of disturbance varying with the sensitiveness or peculiar constitution of the individual, and the distressing symptoms may last long after the exposure has ended. An instance of such deep impression came under my observation last summer in the case of a personal friend who, after accompanying me without suffering in any way, in my visits to some offensive trade establishments, acquired a very severe headache within a few minutes of exposure to the effluvia proceeding from the boiling of Esparto grass in a paper manufactory. The headache was so severe that he said he wished himself dead, and it lasted severely all night and had not disappeared the following day. Probably what is called idiosynerasy was concerned here: and as this gentleman suffered from exposure to one particular effluvium, so other individuals may suffer from other kinds of effluvia which are not productive of definite injury to people in general. Usually such disturbance terminates with the exposure or shortly afterwards. With sick persons, however, it may be otherwise, and sick persons necessarily form part of the various populations which may be exposed to the offensive effluvia from trade establishments. Such persons, sometimes in consequence of their state of ill health, are apt to be more sensitive than healthy persons to impressions on the senses, they may proportionally suffer more distress from offensive impressions, and their recovery may be retarded thereby. I myself, when in practice, saw a case in which serious vomiting with hæmorrhage was induced more than once most distinctly by the offensive smell proceeding from a group of offensive business establishments. The person who thus suffered was a lady subject to hæmatemesis, and she finally died from the hæmorrhage. And further, it is worthy of remark and instructive how constantly, in records of proceedings in courts of law and as the result of my own individual inquiries one particular group of symptoms is mentioned as the most prominent of those resulting from exposure to offensive trade effluvia, and how uniformly this group turns up, whatever difference there may be chemically, or as appreciable by the senses, in the nature of particular effluvia. This group consists of loss of appetite, nausea, sometimes actual vomiting, sometimes diarrhœa, headache, giddiness, faintness, and a general sense of depression and *malaise*. And since these different kinds of effluvia have nothing in common except their

offensiveness, it is difficult to avoid the inference that the symptoms mentioned have their origin in the impression they make on the senses. If health consists, among other things, in the easy, painless, imperceptible performance of the bodily functions (as under any definition it must do), it can scarcely be held that such disturbances as those enumerated, which are quite inconsistent with ease and comfort, but are more or less painful and decidedly abnormal, do not constitute when they are present a condition of ill health—of *dis*-ease, of *mal*-aise—or that offensive effluvia, exposure to which brings about such disturbances (whether of longer or shorter duration) are not in that sense injurious to health, even if the duration of the bodily disturbance is brief. *A fortiori* such effluvia must (I venture to suggest) be held to be injurious to health when, by repetition of the functional disturbances referred to, bodily strength wanes, when habitual lassitude usurps the place of habitual energy, and when, with this, the general feeling of mere enjoyment of living, which thoroughly healthy people experience, languishes.

(*b.*) Deeper a more serious disturbances health.

(*b.*) But whatever doubt there may be (if there be any) as to the validity of the first definition, there can be none as to the second. The difficulty lies in demonstrating its applicability to trade effluvia as productive of the conditions mentioned. If I were writing about the influence of trade effluvia upon the health of workmen (which is not the case) I should have no difficulty at all in the matter, for I might adduce the occurrence of definite forms of disease or actual poisoning among workmen in certain trades, as for instance, among workmen exposed to the concentrated fumes of phosphorus or arsenic, to atmospheres largely charged with sulphuretted hydrogen, chlorine, carbonic acid, &c., or with the exhalations from decomposing organic matters. But it is a different thing to demonstrate that in the diluted form in which, under almost any circumstances, trade effluvia reach persons outside works, such effluvia produce the serious damage to health that this definition involves. Let us see how far we can go in this direction.

Manufacturers ordinary line of argument considered.

But first I must dispose of an *a priori* argument commonly put forward by manufacturers and others interested in offensive businesses. I hear it said very often by manufacturers whom I visit, that it is impossible to believe that the offensive effluvia from their works can injure the health of persons outside, because their workpeople, who are exposed to them far more than outsiders, have exceptionally good health. In saying this they refer to injury to health under this second definition. I intend no offence to these gentleman, for whom I have a great respect, and no disparagement of their veracity, when I say that the invariability of this appeal to the health of their workmen, be the trade what it may, naturally induces one to look somewhat critically at the argument. In the first place, their memories may not always serve them very loyally when they make such a statement, and, if they came to think matters over they might call to mind some suspicious occurrences which would tend the opposite way. In the second place, although it is quite true that many men engaged in the trade from youth till middle age or advanced age are to be met with in such works, who have never suffered from serious illness attributable in any way to their occupation, it does not follow that others have thus gone scatheless. Men may fall ill after a time, leave their work, "go upon their club," and suffer an illness not recognised at the time as the result of their occupation, yet for all that really due to it, and their masters have no knowledge of the cause of their ill health. Such men are apt to be lost sight of or to change their occupation to some other that they consider lighter work or more healthy. But taking the statement, that the men engaged in these offensive trades do not suffer in health from the effluvia, as absolutely [illegible]

various explanations of their immunity may be suggested. For example, in the best conducted works, where the men engaged naturally prefer to remain, having confidence in their masters and their masters having confidence in them, efforts are mostly made to protect the workmen from the effluvia to which their work would expose them, sometimes by the use of respirators, sometimes by carrying off the effluvia by careful and efficient arrangements to the outer atmosphere, and so on. It has more than once happened in my experience that the effluvia have been much more perceptible outside works than within them by reason of this very carefulness. And, again, it is to be kept in mind that the workpeople are mostly of the age and sex which offer the greatest resistance to the operation of ordinary causes of disease; that when in full work they live well, have plenty of fresh air during the intervals of their work and while going to and returning from it, and little care for the future. All this is protective. It may be, and usually is, otherwise with persons residing outside the works and not occupied in them with women and with children in their neighbourhood; and it is no argument against trade effluvia being an exciting cause of ill-health among such persons to say that they may, from their home surroundings, be predisposed to suffer. I fear too much space has been occupied in disposing of this argument. The main question is one of fact, and to be solved as far as practicable by observation and experience.

The *a priori* argument.

It must be at once apparent that it is not practicable to apply the pure method of induction to the solution of the present problem. I have myself been unable, in the time at my disposal, to gather together a sufficient basis of unquestionable facts and duly to differentiate the influence of concurrent morbific conditions; and the opinions of medical men, in a position to form just opinions from facts under their local observation, have not been found always to agree in respect of the influence exerted by particular kinds of trade effluvia. The probable cause of these discrepancies of opinion is that all had not made equal use of their opportunities of observation, or had not equally taken into account all the circumstances calculated to modify their beliefs. The method of induction, however, is not the only method which may be adopted in this report. We are at liberty to look at probabilities, and, arguing partly deductively, to take into consideration the question how far offensive trade effluvia can be regarded as falling into some category to which an established axiom is applicable.

Trade effluvia one element of atmospheric insalubrity in towns.

1°. It must be obvious that trade effluvia constitute one item in the long list of circumstances which cause the air of a town to differ from country air, and so, when present, furnish their quota to the general condition of comparative atmospheric impurity which is associated as cause and effect with the comparative insalubrity of towns.

Trade effluvia to septic origin unwholesome.

2°. Distinguishing, now, between effluvia of one kind and of another, one class of effluvia stands out as distinct from the rest, namely, those effluvia which have their origin in the spontaneous decomposition of organic matters and especially of animal matter, the composite elements of which are being broken up under the operation of a septic ferment. The effluvia from such matters are unquestionably dangerous, and indeed, a fruitful source of much fatal disease. The influence of such effluvia upon the health of persons exposed to them has been fully dwelt upon by Mr. Simon in his Second Report to the Board, from which Report I shall have occasion to quote largely on the first occasion that presents itself of discussing the influence upon health of this class of effluvia as originating from a particular group of businesses. At present I shall

content myself simply with saying that the great leading axiom of all public and private sanitation that "filth produces disease" formulated and illuminated by the late Medical Officer of the Board bringing to bear upon it the rays issuing from modern scientific investigation, has an extensive application to the subject matter of this inquiry. It has specially its application to what are *par excellence* filthy businesses—businesses in which are dealt with organic matters in a state of active septic change, or which are on the eve of undergoing such change, or in conducting which, without due carefulness, decomposing organic matter of the nature of filth cannot fail to accumulate and give rise to offensive effluvia. Deductively, the effluvia from such businesses always lie under a strong suspicion of being injurious to health in the sense of the second definition, while in some instances their morbific character must be regarded as absolutely certain.

On Effluvium-Nuisances, by Dr. Ballard.

3°. There are certain effluvium-producing businesses dealing with refuse matter, in which some of the refuse matters dealt with are liable to be infected with the specific contagia of infectious diseases. Such effluvia, if charged with infectious matter, cannot fail to be dangerous to persons exposed to this influence.

Trade effluvia containing specific contagia dangerous.

4°. The remaining kinds of trade effluvia, so far as the probabilities of their being injurious to health are concerned, may all be considered in one group. They are chemical elements or definite chemical compounds inorganic or organic; some are probably innocuous although offensive, some, even in a diluted condition, irritating to mucous surfaces of the body with which they may come in contact, while others are so decidedly poisonous in their nature that if they were in a concentrated form, they would kill persons exposed to their influence. If, when diluted with air, as they always are outside works, such effluvia are capable, as they sometimes are, of producing in a minor degree their irritating or poisonous effects upon the human body, they must be regarded as injurious to health in the sense of the second definition. But, on the other hand, it has sometimes been suggested that certain of the offensive trade effluvia of this group (such, for instance, as chlorine, sulphurous acid, or tar vapours) are actually beneficial to public health inasmuch as they are well known disinfectants, and are in common use as disinfecting agents. I have over and over again heard manufacturers argue thus: but they do so in ignorance of the fact that, for such disinfecting agents to be effectually operative against any contagium, they must be applied to it in a state of concentration far greater than that of the diluted effluvia met with outside chemical works; and, as respects such as are oxidisers, that they will exercise their oxidising powers upon such dead matter as comes within their reach capable of oxidation, before and in preference to exercising them upon the (presumably) living material of a specific contagium. Of such matter there is in the atmosphere and on the surface of the earth more than sufficient to protect specific contagia from their disinfecting action.

Definite chemical substances, if irritants or poisons, are dangerous.

Fallacy of imputing to them disinfecting qualities.

Reverting now to the results of direct observation and experience, it may be said that, although the statistical argument is practically inapplicable to our purpose, and although there are discrepancies of statement among people professing to observe, there is sufficient evidence at hand to confirm, where confirmation may be needed, the inferences to be deduced from the foregoing considerations, if not enough (as confessedly there is usually not enough) to stand alone as indisputable proof, unsupported by such prior considerations. Offensive businesses are not, as a rule, set down in aristocratic neighbourhoods, and, when they are established, the well-to-do portion of the population does not usually congregate about them. They

Results of observation and experience.

are almost universally found in neighbourhoods where the poorer and labouring classes lodge—classes of persons who are subjected to a variety of unwholesome influences, filth effluvia, overcrowding of population, scanty or unwholesome food, &c., the influences of which are intermixed with, and, unless occasionally under exceptional circumstances, scarcely distinguishable from, those of the business effluvia in question. Now and then these exceptional circumstances may be present, but they have to be sought out, and, when the opportunity arrives, the man is not always at hand who is capable of availing himself of it, or willing to do so. At p. 26 of this report an instance is given, however, in which (the conditions of inquiry being favourable) the differentiation was effected with a result confirmatory of the probabilities of the case. When trade effluvia carried to a distance through the air chance to reach a population otherwise circumstanced, they are commonly so diluted as to render it very questionable indeed whether ill-health attributable to them is not rather such as falls within the first rather than the second definition.

Opinions have been occasionally broached to the effect that certain infectious disorders have been induced by habitual exposure to certain business effluvia, in cases where the infection could not possibly have come from any previous sufferer with the disease. I have heard this asserted, and instances adduced as respects such diseases as enteric fever and scarlet fever—diseases which, so far as we at present know with certainty, never originate except from a specific contagium reaching an individual by some direct or indirect (often very indirect and obscure) channel from a previous case. Opinions of this kind are obviously without value unless they proceed from persons sufficiently instructed in the established doctrines of etiology, and who have succeeded in disproving current beliefs. But on the other hand it is to be recollected that there are spreading diseases, the contagium of which very probably indeed (in some instances one may say with certainty) may be developed anew under the influence of some kinds of effluvia, such as are liable to issue from some business establishments. Erysipelas and its congener, puerperal fever, is one of these, and some observations I shall have occasion to quote hereafter may raise the suggestion that diphtheria may perhaps be one of them.

Again, there is an opinion held that the spread of infectious diseases once introduced into a neighbourhood is promoted by habitual exposure to offensive trade effluvia. The general condition of health commonly known as being "below par," which habitual exposure to the influence of offensive effluvia may bring about, may very easily be believed to predispose to the reception, or development when received, of a specific contagium and to lessen resistance to its operation. Now, on the one hand, in almost all the alleged instances of this event which have been presented for my acceptance, I was satisfied that other better known conditions calculated to favour spread and to dispose to an unfavourable issue had not been sufficiently passed under review. On the other hand, I have the well-considered opinion of careful observers that they have been unable to trace any operation of the kind in respect of the very effluvia which had been thus accused. I may instance the opinions in this direction given me by Mr. Davies, the medical officer of health for Bristol, in respect of the mixed and very offensive trade effluvia in St. Philip's Marsh, and of Dr. Russell, the medical officer of health in Glasgow, in respect of the trade effluvia at St. Rollox and its neighbourhood.

There is, however, sufficient evidence to show that irritating trade effluvia do sometimes effect mischief, by virtue of their irritating quality,

on the persons exposed to them, even at a considerable distance from the works from which the effluvia issue, and after they have undergone considerable atmospheric dilution. Mr. Davies tells me that he thinks it probable that an excess of pulmonary mortality which he has observed in St. Philip's, Bristol, and which is otherwise inexplicable, has been due to this course. With respect to the poisonous gases, such as arsenical vapours and sulphuretted hydrogen, the evidence of experience in the localities where they are given off from chemical works is conflicting, and not always very trustworthy.

On Effluvium-Nuisances, by Dr. Ballard.

No experience that I have been able to gather tends to confirm the notion that any of the chemical fumes proceeding from alkali or bleaching powder works, or from other works giving forth into the atmosphere supposed "disinfecting" vapours, have ever exerted any influence whatever in preventing or arresting the spread of infectious diseases in the localities where such fumes or vapours are perceptible.

IV. In many works in which offensive effluvia are produced, means have been adopted, either voluntarily, or under pressure from local authorities, for preventing altogether, or reducing more or less, the nuisances occasioned by the diffusion of effluvia beyond the works. But there are very many works in which no pains have been taken in this direction. This has partly arisen from want of consideration for neighbours, partly from want of capital and the resulting struggle to make any profit, and partly from the difficulty of disturbing the traditions of the business. The means adopted to prevent nuisance have not always been very efficient, sometimes because the persons consulted by the manufacturer have not always possessed the requisite technical knowledge and experience for advising in such matters, sometimes because outlay of money in the erection of efficient apparatus has been grudged, and sometimes because apparatus, at first probably efficient, has been allowed to become dilapidated. The tendency of the inquiry is towards establishing this point, viz., that all, or nearly all, the trades now causing offence from the diffusion of effluvia may be so carried on as not to cause offence at all, or only offence of such a trifling nature as may well be tolerated by persons who live in communities.

Adoption of means to prevent or minimise nuisances.

Mostly feasible.

There is no difficulty whatever in laying down the general principles upon which the appropriate means of preventing or minimizing effluvium nuisances from business establishments must be based. In dealing with any particular establishment, however, the possible composite nature of the nuisance must not be over looked. For practical purposes several kinds of origin of nuisance effluvia may be recognised. Thus, a nuisance may be dependent:—

Ordinary sources of origin of effluvium nuisances.

1. On accumulation of filth on or about the business premises, or on its removal from the premises in an offensive condition.
2. On a generally filthy condition of the interior of the buildings and the premises and utensils generally.
3. On an improper mode of disposing of offensive refuse, liquid or otherwise.
4. On insufficient and careless arrangements in the reception of offensive materials of the trade, or in the removal of offensive products either from the premises or from one part of the premises to another.
5. On an improper mode of storing offensive material or offensive products within the works.
6. On the escape of offensive gases or vapours given off during some part or parts of the processes to which the materials of the trade are subjected into the atmosphere outside the works.

In the progress of this report, abundant illustrations will be presented of each of these modes in which effluvium nuisances may arise from business premises. I am now only concerned with the general principles on which their prevention is to be based.

General principles of prevention.

As respects the first and second of these sources of effluvium nuisances, the obvious remedy is "cleanliness" in the broadest sense of the word :—

1. Filth should be removed from the premises speedily in the impervious covered vessels in which it ought always to be collected from time to time during the day.

2. Those parts of the interior of the premises liable to become dirty or encrusted with filth or decomposable matter and all the utensils employed should be regularly cleansed. Such structural and working arrangements should be made as shall not only tend to prevent such defilements, but also tend to facilitate cleansing.

3. Solid offensive refuse should be separated from liquid refuse as far as practicable, and each should be disposed of in its appropriate manner, the solids being deposited and speedily removed in covered impervious vessels, and the liquids being run off into proper drains in such a condition as not necessarily to give rise to offensive emanations. Deodorants may sometimes be used with advantage.

4. Offensive matters necessary for use in the business should be brought upon the premises either in covered impervious vessels, or covered up in such a manner that they should not be a source of effluvium nuisance during transit ; they should be so received in an enclosed building, and unloaded with due precaution against the issue of effluvia in the process. Offensive products should be removed similarly from the premises. Precautions should also be used in the removal of offensive products from one part of the premises to another. Difficulties in this respect now and then arise in works from insufficient space or bad arrangements of workshops and receptacles. In such cases as these, modifications may be necessary in the works themselves.

5. Offensive materials and products of the business should either be stored in impervious vessels or in a close chamber ventilated, if necessary, in such a manner that the effluvia shall not become a nuisance.

6. Sometime a careful selection of the materials of the manufacture, or some little modification of the manner of conducting a part of the process may be sufficient to obviate an effluvium nuisance wholly or partially. But where the evolution of offensive gases or vapours is not thus avoidable, they must be intercepted in their passage to the external air, and dealt with in such a manner as to destroy their offensive character. One method of interception consists in arrangements for drawing off in a continuous manner the air of the entire chamber or workshop in which the offensive effluvia are evolved ; but mostly the interception is practicable without doing this. When drawn off or collected, they may, according to their nature, be dealt with in one of five ways : 1. They may be discharged into the atmosphere at such an elevation as that they shall be so diluted before reaching the ground as not to be then offensive. When this will not suffice other means must be used. 2. If the evolved matters be condensible by cold, they may be passed through an appropriate condensing apparatus. 3. If soluble in water they may be submitted to the action of water in an appropriate apparatus, or similarly to the action of any other liquid better calculated to absorb them. 4. Sometimes, in like manner, solid substances, with which the effluvia have chemical affinity may be used with advantage, either in powder or otherwise. 5. If the evolved matters be combustible, they may be burned by conducting them through a fire.

Their particular application requires caution.

These are the general principles on which such effluvia must be dealt with, but their application to particular trades must depend upon a variety

of considerations, even for the same trades, and for the same kind of effluvia. In selecting the method to be used much will depend upon whether or not the collection of the matters in one or the other way would be a source of profit. Rules of universal application can rarely be laid down, for the reason that individual establishments often have peculiarities of working which must be taken into account, while some are wanting in conveniences possessed or obtainable by other establishments. Much caution then is needed, together with a good deal of practical acquaintance with the details of manufacturing processes, in prescribing the actual method which should be used in any particular establishment. Happily, for all parties, it is commonly found in practice to be as much to the interest of the manufacturers as of the public that the emanations from offensive processes should be thus arrested. The offensive matters so recklessly thrown away into the atmosphere are often found to be matters which, if collected, are of commercial value, and may either be sold to advantage or utilised upon the premises. And generally it may be said with truth—truth established by the experience of others beside myself who have given attention to the subject—that the use of due means to prevent effluvium nuisances in industrial establishments of all kinds often turns out to be in a variety of ways direct or indirect, and often unforeseen, conducive to prosperity. This is a fact which those most largely engaged in many of the most offensive businesses now recognise more or less completely. It need scarcely be added that the recognition of this important truth is calculated to facilitate very greatly the action of sanitary authorities in dealing with this class of nuisances. In the course of my inquiries, I have invariably found manufacturers and others largely engaged in offensive trades—the men who have had the greatest amount of experience in them—not only ready to discuss with me the various means that had been suggested or that had occurred to them or to myself, as practicable means of preventing nuisance from their works, but really anxious and glad to do so. This readiness to converse upon the subject has not only tended to the public benefit and has removed many difficulties out of my path, but in addition has imparted to my inquiry a most agreeable feature.

V. Any observations I may find it desirable to make in respect of the difficulties experienced by local authorities in dealing with this class of nuisances I propose reserving until the completion of the Report.

Part I.

On Effluvium Nuisances arising in connexion with Branches of Industry involving the Keeping of Animals.

The Public Health Act, 1875, and the Nuisances Removal Act, 1855, (in force within the metropolis) both recognise the fact that animals may be so kept as to be a nuisance injurious to health. The rearing and keeping of animals for the sake of their produce, for sale, for slaughter as food, or for the sake of their labour, constitute a large part of the industry of the country. Sometimes this rearing and keeping of animals is the ostensible and main occupation of an individual, sometimes it is an occupation incidental to his ostensible and main business, sometimes it is supplementary only to it, the animals being reared or kept for pleasure or for the sake of some [illegible] within 3 feet of the horse's therefrom. A single animal may be so kept [illegible] suggesting that his customers nuisance, but for the most part animals ker[illegible]cry, he explained that he did not [illegible]ract bread."
number.

On Effluvium-Nuisances, by Dr. Ballard.

This part of my report will deal only with the keeping of animals in confinement more or less complete. Such keeping of animals gives rise to nuisance chiefly where human population is aggregated, and the nuisance is more likely to arise, and when it arises to be more serious in character, where the population is dense than where it is sparse. But it is not solely amid aggregations of population that such nuisances may be occasioned. A single animal, badly kept, in or near a solitary house, may be a source of injury to the inhabitants of that house in consequence of the effluvia proceeding from it. Confining myself however, to what is observable in London and large or small towns, and sometimes in villages, I may enumerate horsekeeping, cow-keeping, and pig-keeping as branches of industry which appear to fall so completely within the scope of this inquiry as to require to be dealt with more or less *in extenso*. For the most part the same principles as will be enunciated with respect to horses, cows, and pigs, both as they relate to the general character of the nuisances occasioned, and as to the remedies to be applied, are applicable to dogs, goats, rabbits, poultry, pigeons, &c.

Horse-keeping.

Horse-keeping.

Varying modes in which horses are kept.

A person making it a business to visit stables where horses or asses are kept, as I have done, may observe every grade and variety of mode of lodgment, and of relationship between the lodging of the animals and that of the human beings living about them, from the stables in which the pleasure horses of the rich man are lodged as luxuriously (in their way) as their masters, to the miserable shanty in which the costermonger lodges his pony or donkey. Valuable horses get their share of the personal comforts with which their owners surround themselves; and the decencies of the mansion are reproduced in the stable. On the other hand, the poor man's animal shares his owner's poverty; and cannot be expected to live more luxuriously than he does, or to be provided with appliances for decency and comfort which his master has never learned to feel necessary for himself or his family. But between the scrupulously clean, well paved, well drained, duly ventilated stable, with its polished stalls and neat iron or brass fittings, where the horses are carefully bedded on clean straw, and where manure is removed at short intervals, and the wooden, scarcely weather-proof, lean-to in the little back yard of a poor man's cottage, where there is absolutely no provision for drainage, where the manure and dirty litter are trodden down day after day, and only removed at long intervals, and then only to be accumulated in a heap in some spare corner, there is to be seen every conceivable variety of lodgment. And generally it may be said that the nuisances arising from horsekeeping are less or greater, according as the conditions of the mode of keeping assimilate to the one or the other of these two types. In a close court, more or less densely populated, where several stables approaching the latter type are situated, the nuisance is perhaps at its highest, especially in the summer time. Such courts or narrow spaces between the rears of neighbouring rows of cottages may be met with in London and large towns, and in them a casual visitor is at once struck with the all-pervading and persistent ammoniacal odour which the wind will sometimes carry, not only into the houses of the poor people who reside in the court itself, but also into better houses [illegible] "mews,"* such as are to be seen at the rear of which the effluvia have

* by no means always in the occupation of the person ges to which they severally belong, but are commonly ab owners or tradesmen, and the dwelling rooms r persons.

Their particular application requires caution.

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These are the general prin
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many of the best streets at the west end or in the suburbs of London, are, as respects effluvium nuisances, often little better than such courts as I have just described. In these mews it is customary to see one or more rooms* constructed above the stable, which rooms are either inhabited by the groom or horsekeeper and his family, or let out to other families for residence. Whatever effluvia arise from the stable find their way into the residential parts above. Their passage upwards is in some instances facilitated by the staircase leading to the rooms proceeding directly from the interior of the stables. But even when this is not so, and where there is a separate entrance from the mews to the foot of the staircase, the pervading stable odour still penetrates to the rooms above, either through cracks in the ceiling or imperfections of the brickwork or woodwork of the structure itself.† The internal construction of the stables in a mews, and the appliances for wholesomeness, vary considerably. Some such stables are carefully kept, well paved, and fairly drained, while others may be not only filthy, but paved in such a manner that urine stagnates upon the surface, while the drain inlet, through which it should be carried away, is choked up with dung and filth ; and yet human beings will be content to reside in the upper rooms. In some mews there are one or more dung pits provided for the use of the occupants, in others the dung pit is dispensed with, and each occupant lays his manure in a heap upon the surface of the mews outside the door of his stable, and here it remains until removed by a purchaser or contractor. It is not customary to store the dung in the stable itself.‡ I have often found that no privy accommodation has been provided for the inhabitants of mews tenements : in such cases the excrement of the family is thrown upon the manure heap, or into the common dung pit. Sometimes I have seen a rough privy seat erected over one end of the dung pit, which thus becomes the privy pit also, and one open, moreover, to any passer-by who might choose to make use of it.

Sources of effluvium nuisances.

The effluvium nuisances of horsekeeping proceed mainly from, 1, fermenting filth, solid or liquid, within the stable itself, due to neglect of proper cleansing, to the protracted use of dirty and sodden litter, and to the soaking of urine and excremental matters into the floor, the result of its bad construction or of deficient provision for drainage; 2, the exhalations from the animal's lungs, skin, &c., and in some instances, perhaps, from diseased surfaces; 3, the too prolonged retention of manure in dung pits or dung heaps, and its consequent fermentation ; 4, the disturbance of the fermenting dung for removal, and its cartage through public thoroughfares. The presence of a large number of horses in a very populous and crowded neighbourhood adds to the

* There are no back rooms to these mews-residences. The windows of the rooms open upon the roadway alone, so that there are no means of horizontal or through ventilation.

† Unwholesome dwellings of this kind can be dealt with by Sanitary Authorities as houses "Unfit for human habitation." The erection of such unwholesome residences can be prevented under such building byelaws as Sanitary Authorities are enabled to make, but not in the metropolis, since the 29th section of the Metropolis Buildings Act (the only clause apparently applicable) does not apply to residences arranged as mews-residences are arranged, that is, without back rooms.

‡ As a curious instance of horsekeeping, I may mention what fell within my own experience when a medical officer of health in Islington. I was making an inspection of bakehouses, and in one case I had to pass from a sort of scullery, through a low dark stable, close to the horse's heels, into the bakehouse, which had no other mode of access. A large number of recently-baked loaves were laid on shelves erected against the wall of the portion used as a stable, and within 3 feet of the horse's tail. On my calling the baker's attention to this, and suggesting that his customers would scarcely prefer bread thus stored before delivery, he explained that he did not send this to his ordinary customers—it was "contract bread."

On Effluvium-Nuisances, by Dr. Ballard.

atmospheric pollution produced by the human crowding, and to th resultant deterioration of health. Old stables are often riddled beneat with rat runs, and where these communicate with adjoining houses the may introduce a concentrated effluvium into them from the stables. Thi is most likely to occur where the flooring is bad, and the drains are o brick, or other loose or soft material.

Cow-keeping.

Cow-keeping.

Trade of a dairyman.

Cows are not now generally kept in confinement in towns unless they are large towns. The milk supply is usually derived from some outside country place. But in London and Edinburgh, cowkeeping for the supply of milk to the population, is an institution of long standing. To a less extent it is practised in such towns as Birmingham, and in some smaller towns, but mostly these establishments are, in such towns, situated in the suburbs. Breeding of calves is not practised in London cowsheds; cows are purchased in milk, and when they cease to give milk, are fattened and sold to the butcher. They are similarly sold to the butcher when they fall ill of any disease likely to terminate fatally,

Cowhouses;

as soon as their milk is observed to fail. Cowhouses kept for dairy purposes are often located in narrow streets, in any small space which may happen to be available, and very commonly in the midst of crowded populations of poor people. The dairymen who keep them are often, under such circumstances, men of very small capital, and are satisfied if their cows are so lodged and fed as to give a due quantity of milk, without troubling themselves about the nuisance which results from their improper management or the damage they inflict upon the health of their neighbours or even of their own families. On the other hand I have seen in London most unexceptionable cowsheds, well arranged and well managed, and neither a nuisance nor likely to become so. For the most part, cowsheds in London are much too small for the number of cows crowded into them. Sometimes a dairyman's cowshed is nothing more than some disused stable, or a wooden dilapidated shanty without proper means provided for drainage or the

their ordinary arrangements.

maintenance of due cleanliness. The part of the shed on which the cows stand is usually raised an inch or two, and this raised part extends from the feeding trough as far back as the ordinary length of the cows, so that their hind feet stand at only a short distance from the edge. Beyond this, and at a lower level is usually a passage running the length of the shed. Sometimes a gutter is provided, between the passage and the cows' standing place, for the droppings and urine to fall into, and in the course of this gutter are one or more gully openings leading to the drain. The part on which the cows stand and lie is usually not paved, except for a space of a few feet from the edge, since cowkeepers state that a hard paved surface injures the cows' knees when they lie down. The passage is usually paved in some way. The paving in London cowsheds is usually of ordinary bricks placed on edge. The channel may be of the same, but it is sometimes made of small slabs of stone and sometimes of wood.

Standing places.

The standing places of the cows are usually divided by low wooden partitions into stalls, and two cows are placed in each stall. The width of the stall is just sufficient to allow the cows to lie down, *i.e.*, for single stalls about 4 feet, and for double stalls, not above 7 feet 6 inches. It is said that if more space is allowed the cows are likely to strangle themselves with their halters.

Feeding troughs, food, &c.

The feeding trough is usually of wood or of brick covered with cement. Cows, thus kept, are fed mostly upon hay, mangolds, or

turnips and brewer's grains. Some London cows also get a larger or smaller supply of distillers wash. Grains and wash are believed to stimulate the secretion of milk. Most London cowkeepers keep their cows very warm. The sheds are generally badly lighted and badly ventilated, so that the prevailing atmosphere is very warm and moist. The dung is swept up two or three times a day, and is stored in a dung-pit sometimes outside the shed, sometimes within it. The dung-pit is usually made large enough to hold several days' accumulation, so as to avoid the inconvenience of frequent removal. In these pits, which are mostly of brick, but sometimes of wood, the dung ferments and sometimes becomes exceedingly offensive before it is removed. I have seen instances in which the cowshed is directly entered from the dairy or from the kitchen or one of the dwelling-rooms of the house.

On Effluvium-Nuisances, by Dr. Ballard.

Dung.

I have known establishments varying in the number of cows from 400 to two or three cows. The cubical space allotted to each cow in the sheds has varied within my experience from over 1,000 feet to a little over 200. The largest establishments, as a rule, are those which are best ventilated and which are least crowded. The most unwholesome sheds in London, as a rule, are those which were constructed or in use prior to the time when the licensing system was introduced; sheds erected since that time are vastly superior in every respect.

Capacity of sheds.

The principal effluvium nuisances arising from cowkeeping are dependent upon the filthy mode in which the cows are kept, the storing and removal of the manure, and the storing of the grains on which they are fed. The grains are commonly stored in a grains bin into which they are firmly trodden down. In the process of treading, the liquid matters are pressed out, and when proper provisions are not made for its flowing away into the drains, it stagnates on the surface of the yard and undergoing acetous fermentation emits an odour perceptible at a distance of many yards, and rendering habitations in the neighbourhood scarcely tolerable. Sometimes this precaution of treading down the grains is more or less neglected, and the whole mass of grain acetifies and becomes offensive. When the bin is of wood, the material itself becomes saturated with the liquid, and the bin is a source of great nuisance. Further, as in the case with horses, the presence of a number of cows upon a limited area in a close locality already crowded with habitations, adds materially to the general pollution of atmosphere which such human crowding occasions.

Sources of effluvium nuisances.

Pig-keeping.

Pig-keeping.

It is not necessary to say much in demonstration of the nuisance arising from the keeping of swine. The reports made by health officers in all parts of the country abound in illustration of it. It is a nuisance notorious in every town, and nearly every village in the kingdom. Nor can it be said that large establishments are on the whole less objectionable on this score than the two or three pigs commonly kept by poor men in the rear of their cottages. The fault appears to be that the pig has a bad name as an unclean animal whose habits are essentially and naturally filthy, and who will feast on disgusting food from which other animals of better repute will turn away. He is thus left to revel in the filth that he is supposed to prefer, and no pains are taken, for the most part, to teach him something better. To this popular prejudice I demur. A similar prejudice sometimes excuses neglect in providing sanitary appliances in the case of certain classes of the human population of the country. For I have heard the question asked, What is the good of providing wholesome lodging and appliances for drainage for people

Ordinarily a nuisance.

The pig is not naturally an unclean animal.

whose habits are naturally filthy and indecent? The pig is not naturally an unclean animal; on the contrary, it is naturally a clean animal. When the pigs wallows in mire he merely follows an instinct implanted in him, in common with some other pachydermatous creatures, the object of which is cutaneous cleansing. The mud stands to him in the relation of soap to a human being, but instead of washing it off with water he allows it to cake and dry upon his skin, and then rubs it all off, mud and cutaneous débris together, upon some sufficiently rough surface. Loose hair and cutaneous scurf irritate him and he takes his own way of cleansing his skin from them. Cleanse his skin for him and he will rest in contentment, without offending the eyes of his supercilious betters, often less scrupulous in this matter than he is, by his wallowings, scratchings, and scrubbings. It has long been known that a pig thus cleaned with soap and water not only becomes less objectionable but grows fat more speedily than if left to clean himself in his own way. Similarly as respects his food. A pig does not naturally prefer disgusting food. If left to pick up his living where he can find it, he will eat anything he can find that is eatable, but even then will eat acorns, fallen fruit, or roots in preference to garbage: and human beings in similar straits will act precisely in the same way. I am credibly informed that, even in London, there are men who regularly resort to the dung heaps adjoining certain London slaughter-houses and pick out from them, for conversion into human food, the unborn calves thrown there with other garbage by the butchers. It is not to be supposed that such wretched people would not prefer better food if they could get it. Garbage is not the food that the pig selects by preference. In fact a pig which has been fed for any time upon sweet food will turn away from sour and disgusting food. I have it on the authority of dealers with whom I once had to do at Belle Isle, near the Metropolitan Cattle Market, who used, at the time I speak of, to feed the pigs they had purchased for re-sale on blood and garbage from the abattoirs, that often pigs would nearly starve before they would touch the food set before them, only eating it under the pressure of acute hunger. I am not saying that it is not economical, or perhaps even a desirable thing, to convert into pork matters which can in no other way or in no way more convenient be made subservient to the subsistence of mankind, or that the pig is not properly utilised in this manner. I only wish to vindicate his character as a cleanly feeder, if only he has the chance of cleanly feeding vouchsafed him.

in person,

or food.

Still, as a matter of fact and daily observation, pigs are habitually kept even in the middle of populous towns in a most uncleanly and unwholesome manner, and the outcry against their being so kept is natural and not to be wondered at. Health officers, judging from their reports, would cut the knot of the difficulty by altogether forbidding the keeping of swine within the precincts of towns, or within some defined distance of inhabited dwellings.

Sources of effluvium nuisances.

The offensive odour from ill-kept and ill-managed piggeries will travel with the wind very considerable distances. The nuisance has its source (1) in the filthy condition of the piggeries themselves, the accumulation of manure about them and its removal, often in a fermenting condition, and (2) in the storage and subsequent preparation of the food. The first source of nuisance is dependent partly upon the manner of construction of the sties, which are often mainly or entirely of wood, a material which absorbs offensive liquids and becomes saturated with them in course of time; partly upon the bad construction of the floor of the sties, often again partially or wholly of wood or imperfectly laid with bricks, or sometimes consisting merely of the bare earth; partly upon

imperfect arrangements for drainage of the sties or the absence of any drainage at all, and partly upon neglect to cleanse the dung and filth from the sties at due intervals. As respects the second source of nuisance it is to be remarked that the feeding of pigs upon sweet food is the exception and not the rule of ordinary pig-keeping; the food that pigs ordinarily get is refuse food, tavern wash, or its congener town wash, consisting of scraps of food of all kinds, peelings of vegetables, rind of bacon, pot liquors of all sorts, &c., brewers grains, butchers offal, such as entrails, livers or blood, &c. The swill tub in most towns and villages is an institution wherever pigs are kept, and in many houses too where they are not kept, since its contents have a price; and throughout the year during hot as well as during cold weather the process of filling it goes on. Even when the tub is full, the wash or swill it contains is often not given at once to the pigs, but is kept in store for many weeks or even months, during which time it becomes most offensive from fermentation, while the top of the mixture acquire a layer of mouldiness. The swill is then unmitigated filth, yet is considered good enough for the food of pigs, and indeed their appropriate food. When in this condition, and when dipped out in this condition, the odour is insufferably offensive and sickening. At Calne, one of the most important bacon-curing towns in the kingdom, and where, consequently, nearly every cottager keeps pigs, potatoes, previously boiled, are heaped up in some corner of the back yard and kept there in a sour condition until they form a thick pasty uniform offensive mass, which is then dug out in portions from time to time as food for the pigs. When butchers keep pigs it is not unusual, especially in country towns and villages, to see the sty so arranged as to open upon the dung-pit, into which, together with the manure from the slaughter-house, are thrown blood and such entrails as cannot be used for human food. The pigs rummage in this filth and do a double duty there, eating the blood and garbage that they find and treading down the dung and litter. But sometimes these kinds of food are not given until they have been cooked by boiling, either alone or with meal or potatoes, diseased potatoes being commonly utilised in this way. This boiling of the food is often a still greater source of nuisance than the condition of filth of the sties, and the stench from it often spreads to distances which that from the sties does not reach.

The effluvium nuisances arising from the improper keeping of animals are injurious to health, upon general principles,

Such effluvium-nuisances as I have pointed out as arising from horse-keeping, cow-keeping, and pig-keeping are held by popular professional consent to be nuisances injurious to health; and inasmuch as they are effluvium nuisances due to *filth* in one form or another, the popular professional opinion is endorsed by scientific professional opinion. The late Medical Officer of the Board, Mr. Simon, writes in his second report to the Local Government Board: "Uncleanliness must, I "think, without doubt be reckoned as the deadliest of our present "removable causes of disease. In stating this opinion of its fatal influence, "I do not refer to it in its minor degrees, as compared with high standards "of cleanliness or chemical purity, but refer chiefly to such degrees of it "as fall, or ought to fall, within the designation of *Filth*:—to degrees, "namely, which in most cases obviously, and in other cases under but "slight mask, are such as any average man or woman should be disgusted "at: such as, eminently, the presence of putrescent refuse matter, solid "and fluid, causing nuisance by its effluvia and soakage. . . . It has "been among the oldest and most universal of medical experiences that

being nuisances having their origin in filth.

On Effluvium-Nuisances, by Dr. Ballard.

" populations living amid Filth, and within direct reach of its polluting " influence, succumb to various diseases which under opposite conditions " are comparatively or absolutely unknown; and the broad knowledge " that Filth makes Disease is represented in the oldest records which exist " of legislation meant for masses of mankind. The exacter studies of " modern times have further shown that by various channels of indirect " and clandestine influence Filth can operate more subtly, and also far " more widely and more destructively than our forefathers conjectured." After alluding to the fatal influence of large doses of the offensive gases given off during organic decomposition, he goes on to say, " Far smaller " doses of these fœtid gases, as breathed with extreme dilution in " ordinary stinking atmospheres, both give immediate headache and " general discomfort to sensitive persons temporarily exposed to them, " and also appear to keep in a somewhat vaguely depressed state of " health many who habitually breathe them; but here, so far as we yet " know is the end of the potency of those stinking gases. . . . The " other and far wider possibilities of mischief which we recognize in Filth " are such as apparently must be attributed to *morbific ferments* or " *contagia;* matters which not only are not gaseous, but on the contrary, " so far as we know them, seem to have their essence, or an inseparable " part of it, in certain solid elements which the microscope discovers in " them; in living organisms, namely, which in their largest sizes are but " very minute microscopical objects, and at their least sizes are probably " unseen even with the microscope; organisms which, in virtue of their " vitality, are indefinitely self multiplying within their respective spheres " of operation, and which therefore, as in contrast with common poisons, " can develope indefinitely large ulterior effects from first doses which are " indefinitely small. Of ferments thus charactised, the apparently " essential factors of specific chemical processes, at least one sort—the " ordinary septic ferment—seems always to be present when putrefactive " changes are in progress, as of course in all decaying animal refuse " while others, though certainly not essential to all such putridity, are in " different degrees apt, and some of them little less than certain, to be, " frequent incidents of our ordinary refuse. . . . It is by these " various agencies (essential and incidental) that Filth produces 'zymotic " disease.' . . . Ill ventilated, low-lying localities, if unclean as " regards the removal of their refuse, may especially be expected to " have these ferments present in their common atmosphere, as well as of " course teeming in their soil and ground-water." The main truth thus admirably formulated by Mr. Simon is axiomatic. It is the result of extended experience and protracted observation, and being an axiom, may be duly and logically used in reasoning by way of deduction.* Not only may axioms be thus used, but they ought to be thus used for the benefit of mankind. The practical application of the axiom that 'Filth produces disease' to the particular case of the filthy keeping of animals is self evident. But in order to make the application clearer, I may again refer to Mr. Simon's report and quote some further remarks of his upon the general subject of filth-produced disease. After referring to the fact that excess of disease in filthy places is not always due only to the filth, he goes on to point out that notwithstanding mixed cases, " in filthy urban districts " where the foul air, comparatively incarcerated in courts and alleys and " narrow streets, can act with most force in regard to masses of popu- " lation, the population always shows an increased mortality under " several titles of disease. Such miscellaneous increase of mortality

This is an axiom.

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* " Axioms duly and methodically drawn from particulars will again easily point " out new particulars and so render the sciences active."—*Novum Organum.*

" affects probably all ages, more or less, but a distinctively large pro-
" portion of it attaches to the children. Apparently the mere influences
" of the Filth (apart from other influences) in such a district will be causing the infants and young children to die at twice or thrice or four times their fair standard rate of mortality. . . . In trying to
" analyse the death-statistics of filthy districts we soon find that, with
" regard to many of the separate elements in the miscellaneous
" mortality, we cannot argue in exact scientific terms: partly because very
" large quantities are registered under names which have no definite
" nosological meaning—*e.g.*, 'convulsions,' 'teething,' 'atrophy,' 'con-
" sumption;' partly also because some kinds which we can fairly
" identify by name (*e.g.*, pneumonia)* are such as we do not always
" ætiologically understand; and sometimes we may be only able to esta-
" blish the broad fact that, within the area of Filth, the deaths in total
" amount are greatly more numerous than they ought to be, and that the
" excess (or in mixed cases a certain share of excess) can only be ac-
" counted for as the effect of the Filth." Nevertheless, both experiment and professional experience combine (as he proceeds to point out) to show that septic ferment, however it may enter the blood, is apt to find the way thence to the bowels, so that diarrhœal affections become the most prominent of the diseases distinctively due to filth. Moreover, "experimentally we know of this ferment, that, when it is enabled
" by artificial inoculations to act in its most effective way on the animal
" body, and even more when it has received a curious increment of
" strength which its first propagation within the living body seems to
" bestow on it, it shows itself one of the most tremendous of zymotic
" poisons;" that it develops "disease exactly corresponding to certain very
" fatal and, unfortunately, not infrequent infections to which lying-in
" women, and persons with accidental wounds and the wounds of surgical
" operations, are most subject, but which also occur independently of
" such exceptional states; infections chiefly known under the names of
" erysipelas, pyæmia, septicæmia, and puerperal fever; infections which
" we sometimes see locally arising anew in unquestionable dependence
" on Filth, but of some of which, when arisen, it is perfectly well known
" that they are among the most communicable of diseases. And a further,
" perhaps still more instructive, teaching of the artificial infections is this:
" that the 'common' ferment, which in its stronger actions quickly destroys
" life by septicæmia, can in slighter actions start in the infected body
" chronic processes which will eventuate in general tubercular disease."
After making all necessary reserves in the application of these results of experiment to the condition of ordinary life, he goes on to say that, "looking well at the pathology of human life, under residence in
" foul air, we find ourselves again and again reminded of these results of
" physiological experiment; often seeing phthisis and other tubercular
" and like diseases gradually developed, as though under gradual over-
" powering of the limited normal resistance to the septic ferment: or
" seeing—and particularly where some exceptional bodily state (wounded
" or puerperal) gives opportunity, the sudden invasion of erysipelas or
" other septic infection, not in discoverable dependence on any human
" infectant, but conceivably a filth-inoculation from the air."

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* On the relation of certain cases of pneumonia to filth, an interesting and instructive paper on "Pythogenic Pneumonia," by Dr. T. W. Grimshaw, in the "Dublin "Journal of Medical Science" for May 1875, may be consulted with advantage. See also some further observations of my own as to epizootic pleuro-pneumonia, quoted later in this Report. I may add that during a long service as a dispensary physician in London, I was myself forcibly impressed by the preferential frequency of a fatal form of pneumonia, especially among children, in the filthy ill-drained courts of the metropolis.—E. B.

On Effluvium-Nuisances, by Dr. Ballard.

No illustrations or proofs are necessary in the application of the doctrine thus propounded by Mr. Simon; it is sufficient to say that the universal experience of medical men affirms the fact that diseases, especially those forms of diseases and kinds of death referred to by Mr. Simon, are exceptionally frequent in filthy mews among residents over stables, and where cows and pigs as well as other animals are kept in a filthy or unclean condition, and where the effluvia from such keeping are concentrated within a confined space by peculiarities of locality.*

Illustrations derived from experience.

Nevertheless I cannot refrain from making the following extract from Dr. Buchanan's annual report for 1862 to the Board of Works of St. Giles' district, where he was at that time Medical Officer of Health :—

Dr. Buchanan's observations.

"The main point that appeared needful to be established in evidence "before the magistrates was, that injury was inflicted on the health of "the neighbourhood by the presence of cowsheds in St. Giles'. To "those who had been engaged in observing the sanitary state of the "people through a series of years, this did not appear at all doubtful; "but it seemed desirable to get, if possible, some numerical proof of "such injury to health. With this view, the sanitary statistics of nearly "six years were examined with reference to one particular cowhouse, "that in Stacey Street, which was so situated that its influence on "health could be measured. The end of Stacey Street, at which the "cowhouse is situate, would be expected, *primâ facie*, to have sani-"tary advantages over the other end, which abuts on the middle of "Dudley Street, a neighbourhood which the readers of this report well "know to be unhealthy beyond most other parts of the parish of St. "Giles.' Now, on an analysis of the mortality, it was found that, three "houses excepted, there had been an average of three deaths in each "inhabited house, and in none a higher mortality than six in the six "years. But in the three houses, Nos. 6, 7, and 9 there had been an "average of 10 deaths each; viz., in No. 6, seven deaths; in No. 9, "nine deaths; and in No. 7, actually 14 deaths in the period under "examination. Now No. 7 is the house most directly connected with "the cowsheds; Nos. 6 and 9 are the two houses flanking it. No. 8 "consists only of workshops and the entrance to the cow-yard. In "these three houses, Nos. 6, 7, and 9, 30 deaths occurred, while the

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* Confirmatory evidence of the injuriousness of these filthy effluvia from ill-kept animals may be derived from considering the effect they have upon the animals themselves. I may illustrate this effect by some observations of my own, made on two separate occasions, on one of which pleuro-pneumonia was prevalent in the London cowsheds, and on another when the cattle plague was present in this country. On both of these occasions I took the trouble to compare the prevalence of the disease in the cowsheds in Islington with that of the practice of storing the dung of the animals within the cowshed itself. In the case of the lung disease, I found that in 1857, while 8 out of 31 sheds in which the manure was not stored within the shed had had cases of lung disease, as many as 8 out of 11 in which the dung was stored within the shed had had cases of it. And as respects cattle plague in 1865, I found, generally, that, while 66 per cent. of the sheds in which the manure was not stored within the shed were invaded by the disease, as many as 91 per cent. of those in which it was so stored were invaded; and that the influence of this filthy practice in promoting attack was most obvious in the smallest establishments, which were less liable than the larger ones to the introduction of the contagion; since, while but 53 per cent. of the sheds of the first class were invaded, none at all of this second class escaped invasion. It is in these small establishments that the dung is habitually kept for the longest period of time before removal. The bearing of these facts upon the supply of wholesome meat in towns is obvious. [For a fuller statement of these observations, see Appendix E. to the Second Report of the Cattle Plague Commission, 1866.]

Drs. Druitt and Aldis also mention in one of their Reports the occurrence and spread of "influenza," accompanied by "sore throat," among horses in an ill-kept stable in their district, and that the disease was attributed by the veterinary surgeon in attendance to the unwholesome state of the stable.

"other 14 inhabited houses had only 40 deaths between them. The "only two fever deaths in the street were in these houses abutting on "the cow-yard. Three out of the five deaths from diarrhœa were in "them. Out of 10 deaths from acute lung disease which follow (as "has been often shown) the zymotic deaths in their distribution, and "depend upon similar impurity of air, eight occurred in these three "houses. The Stacey Street cowhouse was the only one in which a "numerical estimate was attempted of the influence on the health of "the neighbourhood. But on the strength of the facts where ascer-"tained, the reply was not difficult to the question of the counsel who "had been retained in the interest of these nuisances: 'Do you mean "'to say that a cowhouse and yard is more detrimental to the health of "'a neighbourhood than if the same space were covered with poor "'houses?'—'Yes, it positively is so.'"

On Effluvium-Nuisances, by Dr. Ballard.

Another extract from Dr. Buchanan's report for 1860, relating to mews may not be out of place. It relates to a place called Southampton Mews, in respect of which proceedings (much delayed) were pending: "Meanwhile, in the summer of 1859, the houses of Bloomsbury "Place and Bloomsbury Square, on which these premises in the mews "abut, were pervaded by bad smells and by zymotic diseases, referred "by the medical attendants of the cases to the miasms of the mews. In "the summer of 1860, again the same smells, and again the same out-"break in the neighbouring houses, this time taking the form of diph-"theritis. In November, a child from the house itself died of diphtheritis "in University College Hospital. And now, in the summer of 1861, "among other complaints, a medical practitioner writes from Blooms-"bury Square: 'As usual, now that the abominations of Southampton "Mews are upon us, and the smell has been most unpleasant, diphtheria "has broken out at No. 25 in this square, also at No. 27.'"

In Drs. Druitt and Aldis' annual reports upon the sanitary condition of St. George's Hanover Square, I find among other illustrations of the injury to health occasioned by mew-stables, the following reference to diphtheria, which, taken in connexion with what has just preceded, and with some observations made in New York, to be referred to presently, is at least very suggestive. In their report for 1868 they mention that in the month of January diphtheria occurred "in one of the "stables in Kinnerton Street, where six children, whose ages varied "between five and fifteen, were attacked with the disease, three of whom "died. The disease appeared in other stables and houses in the same "locality, and some of the patients were taken to St. George's Hospital. ". . The stable was offensive." They further mention the fact that in the fourth quarter of 1858 only three cases of diphtheria occurred in the public medical practice of which they received records. Such cases occurred in a different mews.

Drs. Druitt and Aldis' observations.

In connexion with this last quotation I may quote the following passages from the "Report of the Council of Hygiene and Public "Health of the Citizens' Association of New York upon the sanitary con-"dition of the City" (1865). In respect of the third district, Dr. Hampton Harriott writes: "In regard to the influence of stables upon "the public health, I think that I have, in many cases, traced to their "influence (especially when occupied by sick and disabled horses) an earlier invasion and increased prevalence of such diseases as scarlatina and diphtheria." In respect of the same district, Dr. Keeney writes: "That they produce a deleterious effect upon the health of their imme-diate localities, I infer from the marked and fatal prevalence of certain peculiar diseases in their immediate and most exposed vicinity. Cholera infantum is one of the maladies here referred to." In respect

Observations made in New York.

On Effluvium-Nuisances, by Dr. Ballard.

of the fourth district, Dr. Ezra Pulling writes: "The noxious gases "arising from these places contribute in no small degree towards "vitiating the atmosphere of the crowded tenements by which they are "usually surrounded. A reference to the large map accompanying "this report will show that many of the localities where the existence "of typhus or typhoid fever is indicated are in the immediate vicinity "of stables, the emanations from which appear to be predisposing, if "not exciting, causes of several forms of zymotic disease. Of 44 cases "of erysipelas occurring during the past year, no less than 31 were "adjacent to or within 25 feet of stables. At No. 10——Street, which "is contiguous to one of the largest stables in this district, four cases "of this affection occurred. The rear of No. 27——Street adjoins a "stable, and is within 25 feet of another. In this house, which is "occupied by five families, there were three cases of erysipelas. The "rear of No. 22, Cherry Street, which contains 16 families, is separated "from a large stable by a vacant lot, into which runs much of the fluid "part of the manure. In this house five cases of the above disease "were reported during the year. Zymotic affections of the throat and "lung appear to be very prevalent in these localities where the litter of "stables is undergoing fermentation. One of my colleagues has already "stated to the Council his belief that gaseous emanations from these "sources are conducive to the spread of diphtheria; and while my own "observations tend to confirm his theory, I believe it to be equally true "of an insidious and very fatal form of pneumonia. . . . Indeed, it "may be said that zymotic diseases of all kinds appear to be exceedingly "rife in this region." In respect of the 15th district, Dr. James Ross writes: "At No.——Avenue B, a horse stable occupies the rear "area of the lot, and the entrance to the stables is made only through "the door and hall of the tenant-house. I found two of the scrofulous "children in that house on crutches. The grave has strong claim upon "others. . . . The prevalence and fatality of pulmonary disease among "horses in overcrowded and neglected stables is only equalled by the "fatality of like maladies in the women and children of tenant-houses." In respect of the 16th district, Dr. W. C. Hunter writes: "The "principal insalubrious feature of these stables is their effect upon rear "buildings. This happens when a stable in the rear joins a rear "dwelling next door. . . . A stable is placed in the rear of one street, "and on the opposite street is a rear dwelling-house. The rear walls "of the two buildings are within 2 or 4 feet of each other (this inter-"vening space being an unwholesome 'cloaque'), with a small rear "bedroom window of the dwelling, and a breathing hole for the animal "in the stable; both window and opening being on the same plane. "This is precisely what is seen at No. 278, West Seventeenth Street, "where the bedroom window must be kept constantly closed to prevent "the unpleasant odour from the stables entering the apartment. Three "cases of purulent ophthalmia have occurred here, and typhus prevails "in the front house."

Mode of preventing nuisances.

As to the mode of preventing or minimizing the effluvium nuisances from horse-keeping, cow-keeping, and pig-keeping.

From Horse-keeping.

From Horse-keeping.

The prime essentials of the wholesome stabling of horses are cleanliness and the due removal of manure.

Proper flooring of stables.

1. The flooring of the stable should be of such materials and so laid as to permit the ready flowing away of liquid manure from the standing of the animal. For this purpose the flooring should be as even and

uniform as possible, and such as is incapable of absorbing urine or other liquids that may fall upon it. Hence, the best flooring theoretically, is one which is jointless, firm, and properly sloped to a proper channel. The worst sort of paving that I have seen in ordinary use is that made with round pebbles laid upon the unprepared ground. Brick is too absorbent to make a good pavement, square stones set, and what are termed iron-stone bricks laid upon a duly prepared foundation of concrete are better. But even these are not equal as a flooring to a hard cement. The most perfect flooring that I have seen has been in stables laid with the patent cement of Wilkinson & Co., of Newcastle. It bears very rough wear admirably. It is a cement made with Portland cement and roughly ground stone or granite chippings run upon a basis of brickbats. [See a fuller description below under the head of "Slaughtering of Horned Cattle," &c.] On Effluvium-Nuisances, by Dr. Ballard.

2. There should be provision for proper drainage. The channel leading to the drain inlet should be impervious and even like the flooring or gully. The drains should be of stoneware pipes, which resist the ravages of rats. The drain inlet should be outside the stable and provided with an appropriate trapping arrangement. Drainage.

3. The dung should be removed from the floor of the stable at short intervals. Straw or other litter used for the bed of the animal should not be used a second time after being saturated with urine. Litter, &c.

4. Manure should not be permitted to accumulate in the place provided for its reception, if that place be near enough to inhabited houses to become a source of nuisance from its effluvia. Storage of manure.

When horse manure is necessarily retained on premises for several days (an event which only ought to happen accidentally), it ought to be so stored as not to be liable to undergo compression, the atmosphere should have the freest access to all parts of the deposit, and provision should be made for the draining of all liquid matters from it into an appropriate drain. It has been said that sprinkling the manure freely with dilute sulphuric acid (a cheap agent) assists in preventing the rise of effluvia, but I have have had no experience of this expedient.

5. The flooring of stables should be daily washed down with water, and the walls and ceiling periodically lime-whited, and always kept clean. Cleanliness.

There ought never to be any difficulty in providing, so far as this, against effluvium nuisances arising from horse-keeping. Difficulty begins to appear when the question of residences over stables, as in London mews, arises. It is to my mind doubtful whether the best devised scheme for rendering such residences wholesome would be altogether successful. The principle, however, to go upon in making an endeavour to render them wholesome is, in addition to what has been above suggested, to dissociate by the best known means the atmosphere of the stable below from that of the dwelling-place above, and to provide for the separate horizontal ventilation of the stables and of the dwelling rooms. To carry out the first of these objects it would be necessary to construct the walls of a material which shall be non-absorbent and practically impermeable by stable vapours and gases; and either to construct the ceiling with similar materials, or to interpose an impermeable material between the ceiling and the dwelling rooms above.* In addition to this, the staircase leading to the rooms above should be placed as far as "Mews."

* I am assured by the Architectural Department that there would be no practical difficulty in obtaining such atmospheric isolation, by the use of such materials as glazed bricks, well and closely set in cement, or by the use of good cement for the lining of the walls and flooring of the rooms above.

possible from the stables, should open directly from the street, and its side walls should be constructed of similar impermeable material to that employed in the stable itself, and the staircase should have a distinct and separate ventilation from the roof.

From Cow-keeping.

From Cow-keeping.

The essentials for wholesome cow-keeping and the avoidance of effluvium-nuisances where cows are kept in populous places relate, *a*, to the construction of the cowsheds; *b*, to cleanliness and proper management of the manure; *c*, to the proper storage of their food.

Proper construction of cowsheds, &c.

a.—1. A cowshed should not be crowded. There should be ample space for the circulation of air both at the head and tail of the cows (an object which may be gained by means of a sufficiently wide passage at both ends of the stalls), and the total cubic capacity of the shed per cow, for cows of average size, should not be less than 1,000 cubic feet. 2. The paving should, as respects material, be similiar to that recommended for stables. It should be non-absorbent. The best material is a firm, hard asphalte, or ironstone bricks set in cement, in any case laid upon at least 4 inches of good concrete, or it may be altogether constructed of good firm cement. In London, where usually no litter is provided for the cows to lie down upon, it is customary not to pave the floor towards the head of the stall, on account of the injury likely to be done to the knees of the cows in the act of lying down, but to put in that part a layer of earth, sand mixed with clay, fine brick rubbish, or other soft material. Where litter is used the stalls may be paved throughout. But litter of any kind is objectionable unless renewed daily. It becomes damp and seldom from the exhalations of the cows when they lie down, and is then said to be injurious to the health of the cows. 3. The walls of the shed should be of brick or stone, and faced to a height of at least 4 feet with a dado of good even cement, or with zinc, slate, or other non-absorbent material. 4. There should be good ventilation and lighting. Both lighting and ventilation are best effected from the roof. 5. The feeding trough at the head of the stalls should be constructed of iron or of some other non-absorbent material. 6. There should be a channel of non-absorbent material running along the tail end of the stalls. The pavement should be so sloped as to drain into it, and the channel itself should be of sufficient depth and width and be so sloped as to conduct away liquid matters readily. It should conduct such matters to a pipe drain inlet properly constructed outside the shed. 7. It is desirable that a cowshed should always be a detached building standing in its own yard, but where any part of the shed adjoins a dwelling-house a party wall of non-absorbent material should intervene. In no case should any room of a dwelling-house or any room used as a dairy communicate with a cowshed. 8. The dung should never be stored within the shed. When practicable, a dung-pit should be altogether dispensed with; it never fails to be a source of nuisance to the neighbourhood. The proper plan to adopt would be to place dung at once in the receptacle or conveyance in which it will be conveyed away, and this should be constructed of iron or other non-absorbent material and kept clean.

Mode of dealing.

Cleanly management of sheds.

b.—1. The manure should be swept up and carried to the receptacle at least every six hours, and in the intervals the channel should be kept sufficiently clear for liquid matters to run off, and twice a day the channel and passages should be cleansed with water, and the dado similarly cleansed at short intervals. For this purpose a proper water

supply should be provided within the shed at such an elevation that the water can be delivered by a hose so as to reach all parts that it is necessary to wash. 2. The whole interior of the walls and ceiling should be regularly and periodically limewashed at due intervals. 3. The cows themselves should be kept clean by proper grooming. 4. The manure should be removed from the premises, in the covered receptacles provided, daily or at very short intervals, and the receptacles should be cleansed before their return to the yard. 5. The yard itself should be well paved, preferably in the manner recommended for the cowshed itself, be well drained and kept clean. On Effluvium-Nuisances, by Dr. Ballard.

c.—Grains or other kinds of food likely to become sour should be kept in non-absorbent receptacles outside the shed, and duly protected from the weather. Grains should be well pressed down, and the receptacle should be provided with due means for conducting away into the drain, without exposure to the air, and liquids which may ooze from them. This receptacle should always be thoroughly cleansed within with hot water from time to time of its being replenished. Apparently with a view to facilitate this, the St. Giles' Board of Works in the metropolis requires that there shall be two grain receptacles provided, or if there be only one that it shall be divided by a partition. Proper storage of grains, &c.

From Pig-keeping.

From Pig-keeping.

The most scrupulous care is requisite to prevent pig-keeping becoming a nuisance, when carried on near inhabited houses.

a.—In respect of the construction and arrangement of the sties. 1 They should in no case abut upon or communicate with any part of a dwelling-house. 2. When pigs are kept in any considerable number, a proper enclosed room or building of brick or stone should be provided for the purpose, and it should be lighted and ventilated, preferably from the roof. If the pigs be kept in low sties erected within a yard, the whole sty (*i.e.*, every part to which the pigs have access) should be covered with roofing in such a way as to effectually prevent the ingress of rain. 3. The flooring should be of some material impervious to wet: asphalte or cement, or good glazed bricks, closely laid in cement upon a basis of good concrete are the best materials. It should be properly sloped to a channel running along the front of the sties and leading to a proper drain inlet outside the sties. 4. The walls of the sties should be constructed of impervious materials, such as stone, or slate slabs, or glazed bricks well set in cement, and the feeding trough should also be of some impervious material. No wood should on any account be permitted in any part of the sties. 5. The yard or building within which the sties are situated should be paved in a similar manner to the sties themselves, and be well drained. Proper construction of sties.

b.—In respect of cleanliness. 1. The pigs shall at all times be provided with an ample supply of clean litter. The best materials to use are clean straw or a layer of about 3 inches of sawdust. The litter should be renewed, and all manure removed from the sties, daily. 2. Prior to such fresh supply of litter the floor and walls of the sties should be thoroughly washed and cleansed daily. 3. The pigs themselves should also be cleansed and scrubbed at least once a week with soap and water. 4. The manure and foul litter should be removed from the premises daily. Cleanly management.

c.—In respect of the storage and preparation of the food. 1. No offensive or sour pig food should be kept or used on the premises. If grains are used they should be stored in the manner recommended for cow-keeping. 2. The preparation of food by boiling should be carried on in the manner recommended for tripe and trotter boiling. Proper storage, &c. of food.

Part II.

On Effluvium-Nuisances, by Dr. Ballard.

Part II. Effluvium-Nuisances connected with the Slaughtering of Animals.

On Effluvium-Nuisances arising in connexion with the Slaughtering of Animals.

In this division of my Report I propose confining myself to the slaughtering of horned cattle, sheep, pigs, and horses.

Slaughtering of Cattle, Sheep, and Pigs.

The Slaughtering of Horned Cattle, Sheep, and Pigs for Human Food.

Establishments visited.

Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Nov. 26, 1875	Corporation abattoir.	Manchester -	Blood albumen making, clot drying, blood manure making.
Jan. 19, 1876	Williams (Pigs) -	Bedminster -	Bacon curing.
,, 21 ,,	Skull (do.) -	Bristol - -	Do.
,, ,, ,,	Dole (do.) -	Do. - -	Do.
May 22 ,,	Two large semi-public abbatoirs.	Leeds - -	Separation (at one of them) of serum from blood.
June 9 ,,	Corporation abattoir.	Reading.	
July 27 ,,	Corporation slaughter-house.	Monmouth.	
Oct. — ,,	22 slaughter-houses	Aldgate, City of London.	
,, 26 ,,	Slaughter-houses at cattle market.	Deptford - -	Separation of serum from blood, gut scraping, boiling of flesh, &c.
Nov. 15 ,,	Corporation abattoir.	Croydon - -	Separation of serum from blood.
,, ,, ,,	West and Hayr -	Do.	
,, 28 ,,	Corporation abattoir.	Hereford.	
,, 30 ,,	Do.	Lancaster.	
Dec. 2 ,,	Moore Street abattoir.	Glasgow - -	Tripe boiling, boiling of condemned meat.
,, ,, ,,	Victoria Street abattoir.	Do. - -	Separation of serum from blood.
,, ,, ,,	Scott Street abattoir.	Do.	
,, 6 ,,	2 groups of slaughter-houses or semi public abattoirs.	Newcastle-on-Tyne.	
Jan. 11, 1877	Government slaughter-house.	Portsmouth.	
	Several private slaughter-houses.	Do.	
,, 19 ,,	Corporation slaughter-houses.	Metropolitan Cattle Market.	
,, ,, ,,	Whitlaw - -	Islington.	
,, 29 ,,	Day (Pigs) -	Reading (Cross Street).	Bacon curing, gut scraping, &c.
,, ,, ,,	Day (do.) -	Reading (Munster Street).	Bacon curing.
,, ,, ,,	Thomson (do.	Reading - -	Do.

The Slaughtering of Horned Cattle, &c.—*continued.*

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Jan. 30. 1877	Thomas Harris (Pigs).	Calne - -	Bacon curing and associated processes.
,, ,, ,,	C. Harris & Co. (Pigs).	Do. - -	Bacon curing, gut scraping, &c.
Mar. 22 ,,	Birkett - -	South Shields.	
,, ,, ,,	Gallan - -	Do.	
,, ,, ,,	Tyson - -	Do.	
,, ,, ,,	Postgate - -	Do.	
,, ,, ,,	Cutch (Pigs) -	Do.	
,, ,, ,,	Blakey - -	Do.	
,, ,, ,,	Brown - -	Do.	
,, ,, ,,	Swan - -	Do.	
,, ,, ,,	Taylor - -	Do.	
,, ,, ,,	Another, name unknown.	Do.	
At various times.	Many other establishments.	London and various towns.	

Places where it is carried on.

Slaughtering is usually conducted within a building specially adapted for the purpose; but occasionally this is not the case, and animals are slaughtered for food in an open yard, in some stable or inappropriate outhouse or even within a dwelling-house, in a room, cellar, or shop. On occasion of a visit I paid to South Shields, I observed that in that town, it is the rule, to which there are very few exceptions, for the slaughtering, even of horned cattle, to be conducted in the open shop forming part of the butcher's dwelling-house. And this arrangement exists even in very small shops in the lowest, narrowest, and most unwholesome streets. I am informed, moreover, that the same practice is followed in other towns in that part of the country.

Private slaughter-houses.

Slaughter-houses may be private or public. Private slaughter-houses are commonly located on premises forming part of those occupied by retail or wholesale meat salesmen or butchers and their families, part of the premises being used as a shop for the sale of the meat killed. The position of the slaughter-house in such cases and the facilities of access to it depend upon the position and extent of free unoccupied space at the rear or at the side of the house and shop, and the relation of the premises to public or private roadways. For the most part the slaughter-house is situated at a distance of some yards from the house and shop, sometimes close to them and sometimes it communicates directly with one or both. When there is a public or private roadway from which the slaughter-house can be entered, the animals to be slaughtered are introduced thereby, but when no such convenience exists they may be driven to slaughter through the shop or even through the dwelling-house. The size of private slaughter-houses varies with the nature of the trade done and with its extent. In some instances when sheep or pigs only are killed the slaughter-house is small and low-pitched, but where horned cattle are killed the pitch is generally higher and the slaughter-house more or less capacious. It is not unusual in London, and in other places also, for a private slaughterman to permit other butchers to kill in his slaughter-house when he has completed his own slaughtering. But as I have hinted above, private slaughter-houses are not always situated on the premises used by butchers as shop and residence. Sometimes they are on different (but not distant) premises altogether, and when this is so, the slaughter-houses are usually to be found in neighbourhoods

occupied by poor people, often in narrow, close, ill-ventilated streets, courts, or mews, usually forming part of a row of buildings in such a place, and being entered directly from the roadway. They would not be tolerated in better neighbourhoods.

Public slaughter-houses.

Public slaughter-houses ("abattoirs") are to be met with in a few of our larger towns. In some such towns private slaughter-houses have been almost or altogether done away with. Of those I have seen, the abattoir at the Foreign Cattle Market at Deptford, and the abattoirs at Croydon, Manchester, Reading, Hereford, and Glasgow are unobjectionable as to locality, being either situated at the outskirts of the towns or in places sufficiently isolated. Some, however, such as the abattoirs at Monmouth, Leeds, Newcastle-on-Tyne, and Lancaster are not so well situated; those at Newcastle and Lancaster, particularly, are situated in a closely built part of the respective towns. Mostly, public abattoirs are the property of the Sanitary Authority of the respective towns. This is the case at Croydon, Manchester, Reading, Hereford, Glasgow, Monmouth, and Lancaster, at which last-named place the abattoir is erected close to the dead meat market. At Newcastle there are two abattoirs the property of private companies. Those at Leeds belong to private owners, and I only rank them among public abattoirs because there is a community of slaughtering there. Those at Leeds might perhaps be better called semi-public. I scarcely know whether to class the slaughter-houses at the Metropolitan Cattle Market among the public or private slaughter-houses, for they are let out by the Corporation of the City to slaughtermen in a large way of business, who slaughter only for the supply of the dead meat market, and who only permit private butchers to slaughter there under conditions and restrictions of their own imposing. There is nothing objectionable on sanitary grounds in their position since they are far removed from inhabited buildings. At some of the public abattoirs I have mentioned a part of the building is appropriated for the use of any butcher who may wish to slaughter there, a charge being made for each animal slaughtered. Other parts are so arranged as to give a separate slaughtering place to individual butchers who pay a rent for the part of the premises they occupy. At some of the public slaughter-houses, even among those which are the property of the Sanitary Authority, the latter is the only arrangement in force. But in all cases where public abattoirs are the property of the Sanitary Authority the slaughtering is carried on under regulations imposed by the Authority.

The business of a slaughterman described.

The business of a slaughterman may be considered under the following heads, viz.: 1. The keeping the animals for the requisite time before slaughtering. 2. The actual process of slaughtering and "dressing" of the carcass. 3. The disposal of the offal, garbage, and blood.

1. Keeping of animals before slaughter,

"lairs" and "pounds."

1. As to the keeping of the animals prior to slaughter. Unless a butcher slaughters the animals he has purchased on the day of purchase, he must deposit them somewhere, and at that place they may require to be fed. A place used for this purpose is properly designated a "lair," and in such a place animals may be and are kept for several days. But, again, he must have on his premises and close to the slaughter-house, a place where animals which are intended for immediate slaughter may stand. Such a place is properly termed a "pound." Animals are sometimes kept in the "lairs" for several days, but they are only properly kept in the "pound" for a few hours. In the best public abattoirs, this distinction between the "lairs" and the "pound" is maintained, but in some there is no such distinction. In private slaughter-houses, also, either there is usually no such distinction made, the "pound" being used when necessary as a "lair" or the lair used is not upon the same premises as

the "pound." In some abattoirs, as at Lancaster, there is neither pound nor lair; unless an open space there, undivided in any way, between the abattoirs and the market be regarded as a lair, and a dirty corner at the end of the row of slaughter-houses can be regarded as a pound. In the best arranged slaughter-houses, both public and private, that I have seen, the pound is separated by a free space from the slaughter-houses. But in many, both public and private, even in some otherwise unexceptionable in general arrangements, the pound is actually within the slaughter-house, under the same roof, and virtually only a part of the slaughter-house area partially divided off by a rail or low partition of some kind, or it is a shed or small building communicating directly by a door-way with the slaughter-house. Still more objectionable arrangements are to be met with in the private slaughter-houses of some towns. In a Report made last year by Dr. Spear, the medical officer of health for South Shields, to the sanitary authority of that town, I find a tabulated statement showing among other things that in various (91) private butchering establishments there, the "pound" is located in the following kinds of places, viz.:—In 24 instances the shop itself was used for this purpose; in 14 instances a room of the dwelling-house; in 4 instances a cupboard within the dwelling-house; in 4 instances a cellar within the dwelling-houses, and in 4 a wash-house, sometimes adjoining inhabited rooms. Such places, I imagined, could only be used for sheep or pigs; but I found, on visiting the premises referred to, that even horned cattle are pounded thus unwholesomely in some instances. My experience of pounds in private slaughter-houses has given me a very unfavourable general impression of them. No doubt many that I have seen are well paved and kept clean, but mostly any filthy place appears to be regarded as good enough to put animals in prior to slaughtering them. In some small private establishments where the slaughter-house is situated in the back yard of the dwelling-house, I have seen sheep or pigs kept day after day in the unoccupied part of the yard, sometimes nearly filling it, and creating much annoyance to neighbours by their noise and the odour of their effluvia. I have seen in some pounds (even in London since the licensing period), a layer of trodden-in dung and litter, many inches thick, encrusted upon the floor, and the walls thickly begrimed with filth; while the slaughter-house itself has been clean and limewhited, this being the part of the premises which alone the inspector of nuisances was supposed to concern himself with. When the pound forms virtually part of the slaughter-house area, it is usually cleaned down when the slaughter-house itself is cleaned, but sometimes even under this arrangement I have seen it filthy and neglected. Where public abattoirs are under the control of the sanitary authority, the pound is usually kept in a wholesome condition in the same way as the slaughter-house itself.

On Effluvium-Nuisances, by Dr. Ballard.

2. The actual process of slaughtering. This differs in the case of horned cattle, sheep, and pigs.

2. Actual process of slaughtering,

a. In this country *oxen* are always (except when they are slaughtered in the Jewish fashion) pole-axed. The pole-axe consists of a steel instrument shaped like a large punch, attached to a long strong handle. The ox is led by a rope round its neck or driven into the slaughter-house, and the rope being run through a ring in the wall near the floor at one or more (according to the number of oxen being slaughtered and dressed at one time) particular parts of the slaughter-house, the head is drawn down to a level convenient for the reception of the blow. Sometimes the rope is held by an assistant, and sometimes the animal is blindfolded. Taking a good

of oxen,

On Effluvium-Nuisances by Dr. Ballard.

aim, such as only long practice will ensure, the slaughterman with one swing of the pole-axe, drives it into the centre of the crown a couple of inches in front of the horns, and the ox instantly falls heavily upon the floor. By the opening thus made, a long cane is run into the vertebral canal. As the animal lies on its side, the slaughterman then drives a knife deeply into the carcass above the sternum so as to cut thoroughly into the large vessels behind that part, and the blood gushes out freely. When it begins to run feebly, the slaughterman presses upon and kneads the abdomen and sternum so as to promote the flow and press the blood out. The blood, as it flows, is received in shallow iron vessels and set aside, or is allowed to flow out upon the floor of the slaughter-house and into what is termed a blood-hole, that is to say, a sunken paved or cemented receptacle the size of which varies in different slaughter-houses. In this process a certain quantity of blood rarely fails to flow upon the pavement and into the drain. The carcass when sufficiently bled is then turned over upon the back, in which position it is supported by what are termed "prytches." A prytch is a stout stick of wood about 2 feet long, provided at each end with a stout iron point. The point at one end is forced against the carcass, while the other point is slipped into little shallow holes in the floor which are termed "prytch-holes." An incision through the skin is then made along the whole length of the carcass, the skin is turned backed sufficiently, and the abdomen opened and partially disembowled. The head and neck are flayed, the horns are chopped off so as to be left upon the hide, and the head and feet are cut off. The sternum is sawed in the middle line along its whole length and the symphysis of the pubes also. The ends of a stout wooden bar are then introduced between the hinder leg bones and the tendons, and by this bar the carcass is hoisted head downwards into a perpendicular position by means of pulleys. The disembowelment and the flaying and dressing are then proceeded with. The omentum containing fat is cut off and hung on a hook to cool, and other portions of the folds of peritoneum containing fat are similarly removed. The portions of intestines to which fat is attached are removed to a table where the fat is cleaned off and set aside for the fat melter. The paunch and second stomach are separated; the former is opened and the contents removed, being either thrown upon the floor of the slaughter-house or put into an appropriate receptacle, and the paunch is then hung up on a hook. The second stomach is set aside for preparation as dogs' meat. The intestines, when freed from fat, if not otherwise required for pigs' or dogs' food, go away with the manure. Of the thoracic viscera the heart is used for human food, while the trachea and lungs are hung up for use as dogs' or cats' food. In this process more or less blood and other animal fluids and manure are spilt upon the floor, varying with the degree of carelessness of the slaughterman—the spilling of more or less is inevitable.

of sheep,

b. In slaughtering a *sheep*, the animal is laid upon its side and a knife is run through the throat so as to sever the larger vessels. The blood is usually collected in an appropriate vessel. Where several sheep are to be slaughtered they are commonly laid side by side upon a wooden stand or table having a channel at one end leading to a spout or opening. The throat is cut over this part of the stand, and the blood flowing out is collected in a vessel below. The dead carcass is then lifted off and laid on the back upon the floor, and an incision is made through the skin along the whole length of the abdomen and neck, the skin is partly turned back and then the carcass is hung up by the hind legs upon hooks. In this position the flaying is completed, and the viscera are removed and thrown upon a table, where the fat is removed for the fat

melter, the paunch is cut open and its contents emptied out either into an appropriate vessel or on to the floor, and it is then hung up; the small intestines are set aside in a tub for the gut scrapers or with the remainder of the viscera sent away with the manure and garbage or set aside for the food of dogs or pigs. This process is not necessarily a very uncleanly one; little or no blood or animal fluid need be spilled upon the floor. The carcass is then dressed for sale.

of pigs.

c. Pigs are slaughtered by running a pointed knife into the throat in the middle line, directing it towards the large vessels of the thorax. The blood is either collected in appropriate vessels for use, or allowed to run into a blood-hole in the slaughter-house. In some large pig-killing places the practice obtains of first stunning the pig by a blow from a heavy mallet upon the head. In this way the noise otherwise associated with pig killing is avoided. At Harris' establishment at Calne, where as many as 150 pigs are killed in one morning before 7 o'clock, the arrangements are as follows. The pound, slaughter-house, and singeing oven adjoin one another, and there is an iron rod extending overhead from the pound through the slaughter-house to the singeing-oven. Mr. Harris objects to the use of the mallet, because while preventing or lessening noise it bruises the eye pieces, rendering these parts, he says, unsaleable. A chain is slipped round one hind leg of the pig in the pound, and it is then hoisted by a pulley and hooked on to the iron bar, which slopes downwards a little from the pound. The struggles of the animal thus suspended head downwards cause it to slide into the slaughter-house, and bring it over a blood-hole in the floor, leading to a tank below. Here, close to the wall, the pig is steadied and stuck; much of the blood runs into the blood-hole, and as the animal struggles it slides on a few yards towards the singeing oven, blood still flowing from the throat, and being scattered a little about by the animal's struggles. Most of it, however, falls into a shallow channel in the seamless, non-absorbent pavement, which channel leads to the blood-hole. After singeing, washing and scraping, the carcass is again suspended by both hind legs upon another rod, and opened by cutting along the middle line of the abdomen and eviscerated. The bladder is carefully removed, the urine squeezed out, and then is thrown into a pail of water prior to preparation for the reception of lard. The intestines are removed and thrown down a hopper into a room below; the thoracic viscera are removed and hung upon hooks against the wall. The fat lining the abdominal parietes, and that about the kidneys, is carefully stripped out and hung up above the carcass, and the whole is then run along the same rod to another part of the building near the ice house to cool and set.

3. The disposal of the blood, inedible offal, and garbage.

3. The disposal of the blood, offal, and garbage.

The *blood* is dealt with in one of three or four ways. 1. Pigs' blood is sometimes used as food, being, with portions of fat, run into sausage skins and boiled to make what are termed black puddings. Sheeps' blood is, in some parts of the country, similarly utilised. 2. Or the blood is used as food for swine. I have several times seen it thrown upon the dung-heap in the yard to which pigs kept by the butcher have access. Sometimes it is sent away in barrels to pig-keeping establishments, and, either alone or mixed with other kinds of food, given to the pigs. 3. It is collected in pails or similar deep vessels and stirred or whipped with a bundle of twigs to remove the fibrine. The fibrine is put with other garbage, and the beaten blood is transferred to a barrel in which it is sent away either to persons who prepare it for use in Turkey red dyeing, or (as I am informed) in some instances to the cider merchant. 4. The blood collected either in shallow or deep

On Effluvium-Nuisances, by Dr. Ballard.

vessels, as may be most convenient, is allowed to coagulate, and in this condition is sent away to the manufacturers of blood albumen. It is often arranged at public abattoirs that a manufacturer has part of the premises in occupation for the performance therein of the first process of the manufacture. This is the case at Deptford, Manchester, and Croydon, and at one of the semi-public abattoirs at Leeds. At the Metropolitan Cattle Market such manufacturers have establishments just outside the market area. When the establishment to which the blood is to be sent is at a distance, blood casks are commonly used, and they pass to and fro between the slaughter-house and the manufactory either of albumen or manure.

The *tripes* (1st stomach) of sheep and oxen are slit open and their contents emptied either on to the floor of the slaughter-house or on to the surface of the yard outside or into appropriate vessels. In the first case these matters are swept up into a corner of the slaughter-house and often left there with blood and other matters swept up with them until the end of the day.

The second stomach is set aside either in a corner of the slaughter-house or yard, or in some appropriate vessels, until sent away for food of dogs or pigs.

The *small intestines* (running gut) are stripped from fat and put into a barrel or cask for removal to the gut scrapers, or, if there be no gut scraper to take them, they, with other gut, for which no other use can be found, are thrown upon the dung-heap or sent away with other garbage or used as food for pigs. The large intestines of pigs are used as human food, the small intestines go to the gut scrapers or are scraped on the pig killer's own premises for use as sausage skins.

The *hearts, livers, and lungs* are set aside and hung up in preparation for sale either as food for man or animals.

Hides and *skins*, and the feet of oxen, are usually laid aside in some part of the premises until they can be removed by the dealers in those articles. Hides go to the tanner, skins to the fellmonger, and the feet of oxen to the tripe boiler.

The *fat* is hung up on hooks if the pieces are large enough. Small pieces are usually put into a bag. In towns the fat is usually speedily removed from the premises by some fat melter who collects it, but in country villages it may remain for several days, long enough in the summer time to become offensive. Pig killers render the fat into lard upon their own premises.

Sources of effluvium nuisances.

The effluvium-nuisances arising in connexion with slaughtering are usually confined to the immediate neighbourhood. They may depend 1. On the uncleanly manner in which the animals are kept prior to slaughter, and (especially if sheep) to the peculiar odour arising from the animals themselves when they are kept in an open yard close to the windows of inhabited houses. 2. On the uncleanly condition of the slaughter-house (a condition which is aggravated when it is not properly paved and drained) or an uncleanly mode of conducting the several processes of slaughtering. Where there are no proper means of drainage, blood and filth may flow out upon the surface of the ground outside the slaughter-house, and there, stagnating and becoming decomposed, they may give rise to offensive effluvia. 3. On the retention and accumulation upon the premises of hides, skins, blood, fat, offal, dung, and garbage, which after a time varying with the state of the weather undergo decomposition and become offensive. 4. On the uncleanly condition of blood tubs or other receptacles either kept in the slaughter-house or in the yard. 5. On blood and other decomposable animal

liquid matters flowing into drains with which untrapped drains, or imperfectly trapped drains, of other premises communicate directly or indirectly. The utmost care is necessary to prevent a slaughter-house in a populous neighbourhood becoming a nuisance.

In South Shields, where sheep and oxen are slaughtered in the shop forming part of the dwelling-house, it is customary to see a blood-hole about 2 feet square and 18 to 24 inches deep in the middle of the shop floor. In this at the time of slaughtering the blood is collected, and the practice is to throw in sawdust, with the object of sopping up the blood, so as to permit of the blood being readily removed the following morning by the public scavenger. Most of the blood-holes I saw, however, had not been thoroughly emptied and cleansed, enough blood having been left at the bottom and corners to give rise to putrid emanations, especially in the warm weather. In some of these cases, the chief supply of air to the dwelling-house was through the shop, and the odour of an ill-kept slaughter-house was perceptible in most parts of the residence, Similarly the effluvia from the animals pounded within the house must diffuse themselves throughout it, and probably give rise to a condition of the atmosphere practically identical with that arising from human overcrowding, and calculated to bring about similar evil consequences.

These nuisances may be injurious to health.

The nuisances above referred to may, by their operation on the senses, produce similar functional disturbances to those which evil odours from other sources are apt to occasion, and in so far as they are filth nuisances, they are unquestionably injurious to the health of persons exposed much to their influence.* Considering the loose and unwholesome manner in which slaughtering is carried on at South Shields, I asked of Dr. Spear, the Medical Officer of Health there, and of some other medical men practising in the neighbourhood the opinion which their experience had led them to form as to the injury inflicted thereby upon health. Dr. Spear tells me that he has arrived at a very decided opinion on the subject, and has consequently (but hitherto fruitlessly) moved the local authorities of the districts for which he has been appointed to provide a public abattoir, and thus to place themselves in a position to deal with the unwholesome slaughtering places in their several districts more efficiently than they can now deal with them. He says that in his experience during the two years that he has held office, the houses where slaughtering is carried on have been chief foci of zymotic diseases, and that in tracing back outbreaks of such diseases in the town he has, on more than one occasion, traced back the infections to these houses, and has been unable to trace it back farther ; and that, in common with many of the medical practitoners, he is of opinion that

* Dr. Alfred Carpenter has stated his belief ("Lancet," 1871, Vol. I., and "Public Health," April 1874) that blood and garbage from slaughter-houses, when undergoing decomposition, may cause the development of scarlatina in persons exposed to their effluvia. He lays considerable stress on the influence of decomposing vertebrate blood in giving origin to this disease. To my mind the observations he has recorded fall very far short of affording proof of his proposition. But as the opinion of Dr. Carpenter has attracted (as any opinion he may broach deservedly attracts) professional attention, I feel bound to notice it here. I have inquired of several health officers, on whose judgment I could rely, and who knew of Dr. Carpenter's paper, as to their experience of such a relationship between scarlatina and slaughter-house effluvia, as Dr. Carpenter suggests, but none of them felt themselves in a position to affirm it. Dr. Spear, of South Shields, however, told me that in two instances during the two years he has held office, he had traced back the infection of local outbreaks to butchers' premises, being unable to trace it back any farther; but he properly hesitated to say that this was anything but an accidental circumstance, of that a similar apparent origin might not in other instances have been traced back to, say, the premises of a grocer. I must say, nevertheless, that Dr. Carpenter's hypothesis is, in my opinion, worthy of closer investigation than it has yet received.

On Effluvium-Nuisances, by Dr. Ballard.

the course of zymotic diseases and the type assumed by them have been unfavourably influenced by exposure to the slaughter-house effluvia. There appears, moreover, to be a general impression among medical men that women living in the houses where they are exposed to these effluvia make bad recoveries after child-birth. Dr. Bradley, of Jarrow, told me that so strongly was he impressed with this fact as the result of a long and extensive obstetric experience, that it was now a rule with him to advise women approaching their confinements to quit such places. He could not say that the women suffered as the result of their surroundings from puerperal fever or definite disease after their labours, but they had "bad gettings up," that is to say, their recovery was tedious, and interrupted by undefined ailments, such as irregular attacks of feverishness, headache, want of appetite, &c., &c., which led them to require more medical attendance than is customary after confinements, and which kept him often in a state of anxiety.

directly or indirectly by damaging the quality of meat.

And there is also another less direct way in which the effluvia from a badly kept and badly managed slaughter-house may conduce to injury to public health, namely, through the influence which the septic effluvia from them may exert upon the recently killed meat. It is a common practice in England to hang up the dressed carcases to cool and "set" within the slaughter-house. When the slaughter-house is too warm or charged with septic effluvia the meat not only cools slowly and sets slowly, but is liable to imbibe septic matters from the slaughter-house atmosphere. Keeping animals pounded in the slaughter-house itself, is calculated to maintain too elevated a temperature, and septic effluvia must be abundantly present in the air when the slaughter-house is badly kept and badly arranged or managed; such effluvia, for instance, may originate from the pound, either when within the slaughter-house or freely communicating with it, from blood or filth left in the slaughter-house, encrusted upon the walls or lying in the fissures of the flooring, from skins or fat too long retained, or from a drain having its inlet within the slaughter-house itself. And such slow setting of the meat and absorption of septic ferments are apt to conduce to early decomposition of the meat, especially in the warmer season of the year, or when the meat is the produce of animals which, although diseased, are not so diseased as to render the meat in the opinion of judges of meat unfit under favourable circumstances for human consumption. Putrid meat, meat obviously tainted, is carrion, and probably would hardly find a purchaser; but it is well known to medical men that some meat apparently good and wholesome, meat not obviously tainted, may produce when cooked and eaten very serious disturbance in the system of the consumer, symptoms distinguishable with difficulty from choleraic symptoms or symptoms of irritant poisoning. I have seen some such cases myself; and it has been believed that the functional disturbance has been due to some alteration in the meat, possibly in the fat, having affinity with putrefaction, but not itself the ordinary putrefaction which betrays itself by odour. It has appeared to me not improbable that the septic ferment present in all ill-managed slaughter-houses in which the meat has cooled and set slowly, may in some cases have been concerned in bringing about this result. I have never attained absolute proof of this, but the possibility of the occurrence is sufficiently clear to impart a caution of a practical kind.

Mode of preventing nuisances from slaughtering.

The essentials of slaughtering so as to avoid nuisances are scrupulous cleanliness of the slaughter-house and pound, of the atmosphere of both, and of all utensils, and the speedy removal of all decomposable matters. The business ought to be so worked that, except during the time when actual slaughtering is going on, there should be no unpleasant

odour of any kind perceptible within the premises or proceeding from them. In order to ensure these results much care is requisite in respect of details of construction of the buildings, and in respect of the mode of conducting the business.

1. As to the arrangement and construction of the buildings.

1. By due arrangement and construction of slaughter-houses.

1. The slaughter-house and pound should not be contiguous to any inhabited buildings; *à fortiori*, they should not, either of them, be within a dwelling-house or directly or indirectly communicating with one. The slaughter-house and pound should be two distinct and separate buildings, or should at least be capable of being entirely shut off from each other. 2. The inner surface of the walls of both should be of brick or stone, and the surface should be covered with a layer of limewash which can be renewed from time to time. The lower parts of the wall to the height of 5 or 6 feet should be covered with smooth cement, slabs of slate, zinc sheeting, or some similarly impervious material capable of being washed clean with water. At Mr. T. Harris' slaughter-house at Calne, where, from the mode of killing, blood becomes scattered high upon the wall, the whole of the walls are covered with a smooth cement. There should be no exposed woodwork within the slaughter-house; any woodwork which there may be should be covered with a layer of paint or tar or zinc sheeting. 3. The flooring of the slaughter-house should be of some uniform material, sufficiently even to be capable of ready and thorough cleansing with water and a brush, and sufficiently rough to avoid slipping upon it. At the same time it should be firm and incapable of giving way under the fall of heavy beasts, or of breaking under rough usage. Paving with York flagstones set with cement is the paving most commonly met with both in London and in the country; and it is I find generally preferred by many slaughtermen, whose opinion is worth having, to any other paving of a jointed character. If used it should be laid upon a firm basis of 4 to 6 inches of good concrete. But the objections to it are its slipperiness when blood and other matters from the animals slaughtered become spilt upon it, the tendency there is to the cracking and loosening of the stones (when blood or other liquids may percolate between them and through the cracks), and the frequent loosening and breaking away of the cement with which they are set, partly as the fault of the slaughtermen who commonly use the intervals between the stones for the support of their prytches, instead of using the prytch holes provided in the surface of the stones themselves. The best paving of all is an even jointless paving, sufficiently hard and firm to resist rough usage, and sufficiently rough not to be slippery. Such a pavement is furnished by some concrete and some asphalte compositions. For example, I recently saw at Newcastle-on-Tyne 17 slaughter-houses forming an abattoir constructed in 1869 by a private company, and which have been in use ever since for the slaughter of horned cattle and sheep. The flooring of these and of the approaches to them is made of a cement laid down by Wilkinson and Co., of Newcastle. It consists of good Portland cement, mixed with roughly ground stone or granite laid upon a basis of small brick-bats, the whole thickness of the flooring being about $3\frac{1}{2}$ inches or 4 inches. It had worn admirably, was free from slipperiness, and had not cracked anywhere. It was very readily cleaned, and was as perfect a flooring for a slaughter-house as could be devised. The butchers using the slaughter-houses spoke of it in the highest terms of commendation. Ordinary asphalte is unfit for use in slaughter-houses; it is too soft in the summer, and readily yields to blows or pressure. It has been a failure wherever I have seen it laid down. But

On Effluvium-Nuisances, by Dr. Ballard.

at West and Hayr's private slaughter-house at Croydon I saw last year a flooring of asphalte composition which had been laid down by Claridge's Patent Asphalte Company, and which appears to meet all the requirements of an extensive business. When I saw it in November it had been in use for eight months, had not softened at all by the summer heats, and showed then no signs whatever of wear, although I am informed that about 80 beasts and 500 sheep on an average had been slaughtered upon it weekly. It was rough enough not to be slippery and was very firm and hard. It was laid upon concrete made with cement. The pytch-holes were iron thimbles imbedded in the composition before it hardened. A good cement pavement may also be seen at Mr. Whitlaw's, Seven Sisters Road, in the north of London, which is in as good condition now as when it was laid down nine or ten years ago. Both beasts and sheep are slaughtered at this place. When first it was laid down it was slippery, but this was obviated by ridging the surface a little. It has never required any repair. With a jointless paving and with the wall surfaces protected as I have recommended, it is possible to maintain perfect cleanliness and sweetness of the whole inner surface of the slaughter-house. 4. The paving should be so sloped as that liquid matters shall run off to a proper channel leading to the inlet of a duly laid pipe drain. This inlet should be outside the slaughter-house and should be provided with means of arresting the flow of anything but liquid matter into the drain. 5. Slaughter-houses and pounds should be separately and very freely ventilated, preferably by louvres at the roof or in opposite walls, so as to provide for a horizontal movement of air across all the upper part.

2. By proper mode of conducting the business.

2. As to the conduct of the business.

1. During the process of slaughtering as much care as possible should be taken to prevent the discharge of blood or other animal matters upon the floor of the slaughter-house. The emptying of the contents of the viscera should, where practicable, be performed in a separate place, and any filth should be swept up from the floor and taken away at short intervals. 2. Hides, skins, blood, fat, offal, dung, and garbage should be removed from the slaughter-house as speedily as possible, and while they remain on the premises should be so kept as not to become sources of nuisance. Where hides or skins are necessarily retained for a day or two before they can be removed, they might without injury be advantageously (especially in the summer) brushed over on the fleshy side with a solution of carbolic acid or some other antiseptic. Fat should be freely exposed to the air in a cool place. Blood, offal, dung, and other garbage should be placed in covered, movable receptacles, constructed of galvanised iron or other non-absorbent material. Such articles as have been last mentioned should be, under any circumstances, removed from the premises, without undue delay, in the vessels in which they have been placed. A dung pit, as a substitute for immediate removal, need not be requisite in any urban sanitary district properly administered. 3. Immediately slaughtering is completed, the whole slaughter-house floor and walls (to the height of the impervious portion) should be thoroughly washed with water, and the pound thoroughly cleansed. All the vessels and implements used in the slaughtering, or brought from outside into the premises, should be made and kept clean and sweet. The inner walls of the slaughter-house and pound should have their surface periodically renovated by lime washing.

The Slaughtering of Horses.

Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875, and subsequently.	Harrison - -	Belle Isle, Islington.	Boiling of flesh, &c.
Dec. 11, 1875	Shaw - -	St. George's Southwark.	Do.
Jan. 21, 1876	Kent - -	Bristol - -	Do., artificial manure making.
April 1 „	Town - -	Melton Mowbray -	Artificial manure making.
Dec. 4 „	Glen Park knackery.	Glasgow - -	Boiling of flesh, &c.
„ „ „	Hodgkinson -	Do. - -	Do.
Jan. 10, 1877	?	Near Portsmouth -	Do., pig-keeping.
„ 19 „	Stronach - -	Belle Isle - -	Boiling of flesh, &c.
Feb. 13 „	Adams - -	Birmingham -	Do., preparation of white leather.
Mar. 27 „	Arthur - -	Greenock - -	Boiling of flesh, manufacture of animal charcoal, artificial manure making.
„ 15 „	Walton - -	Cambridge -	Boiling of flesh, manure making, pig-keeping.

Knackeries.

The establishments where horses are slaughtered are termed "knackeries." Diseased oxen or sheep which are manifestly unfit for human food are also often and properly slaughtered in these establishments. Knackeries are sometimes situated, as in London, in populous but poor neighbourhoods. In the country they are usually located in the suburbs of towns. Those I have seen vary greatly in character, as in size. In London, Glasgow, and some large towns they are large, more or less well-arranged establishments, and are often conducted either without creating effluvium-nuisances or with little creation of nuisance. But in out-of-the-way parts of the country, and even sometimes in the close vicinity of towns, the slaughtering of horses is conducted in small and very ill-arranged and ill-constructed places, where the nuisance they occasion in one way or another is much complained of. The business of a horse slaughterer may be considered under similar heads to that of a slaughterer of oxen and sheep.

The business of a knacker described.

1. Keeping of animals prior to slaughter;

1. As to the keeping of the animals prior to slaughter.—The animals are sometimes brought to the slaughterer in larger numbers than he can dispose of on the day they are brought, and horses may have to be kept by him and fed for one or more days before it is convenient to kill them. Besides, the knacker not only receives live animals for slaughter, but as a legitimate part of his trade dead ones also, animals which have died from disease or accident or which have been slaughtered elsewhere; and for such dead carcases he must provide a place, and he must, to avoid nuisance from their decomposition, dispose

a knacker also receives dead animals.

of their carcases before he can deal with the living animals on his premises. In seasons of epidemic disease his yard may be so overloaded with these carcases that the work of disposing of them has to go on both by night and by day. In the time of the cattle plague in 1865 so many carcases of cows were received by one of the largest knackers at Belle Isle that they had to be buried, and were buried in large numbers on the premises. The pound for living animals is usually an enclosed covered and paved space apart from the slaughter-house. In small establishments there is often no pound, the animals awaiting slaughter being merely tied up in some part of the yard.

2. Actual process of slaughtering;

2. As to the actual process of slaughtering and disposal of the flesh.—Horses are first pole-axed and then bled, after the manner of oxen, by cutting down above the sternum, and the blood is collected in vessels for various purposes. The carcass is then laid upon the back, and, the legs being held up by ropes to a beam above, is flayed, the feet are cut off, the viscera are removed, the subcutaneous fat is cut off separately, all the flesh is cut off the bones, and, finally, the skeleton is broken up. The slaughter-house in which the animal is killed is usually paved all over, although not always in the same way or with the same material in all parts; and a part of the area is appropriated to the boiling of the flesh and fat. Bone boiling, then, is one of the processes carried on at a knackery, and so also is the boiling of flesh for dogs' and cats' meat or for manure, and for the extraction of the fat. When the process of bone-boiling is carried on, it differs in no essential respect from that pursued at ordinary bone-boiling establishments, so that what I may have to say upon this subject will be said when I come to treat of this trade; but it is not unusual for the bones to be sent away to a professed bone-boiling establishment. The boiling of the flesh and of the fat (with water) will be described under the head of "Boiling of Flesh, &c."

other processes carried on.

3. The disposal of the offal and garbage.

3. As to garbage and offal. The only parts of the animal (except bones) sent away unboiled from the premises are the feet (from which the iron shoes are first removed); the tails, after all hair has been cut off, and the manure found in the carcass. The intestines are first emptied of manure and then boiled for dogs' meat. Fœtusses found in the carcass are usually sent away with the manure.

Sources of effluvium nuisances.

The effluvium-nuisances from knackeries may proceed from various sources: 1. The pound, if ill-kept, and especially if a number of diseased animals be kept there for any length of time, may be a source of nuisance from the effluvia of the animals themselves, and of their excreta. 2. The slaughter-house may be a source of offensive effluvia if it be dirty and kept in an uncleanly condition. 3. Dead animals on the premises may give rise to effluvia by their decomposition before being flayed and boiled up. 4. The dung and garbage may also be a source of offensive effluvia, either while retained on the premises or while in process of removal. 5. The steam issuing from the pans always has an odour which, never anything but unpleasant, may, when the matters boiled have undergone any amount of decomposition, become absolutely nauseous, and the offensive odour may extend a long distance from the knackeries. The steam issuing from the hot flesh removed from the pans and laid to cool is similarly offensive. 6. When the liquor from the pan is run off by open channels, similar offensive smells are given off, and when run off hot into drains may give rise to offensive effluvia from neighbouring drain inlets communicating with them. Where other trades are associated with that of a knacker upon the

same premises, the effluvium nuisances observed may proceed in part or entirely from these trades. Thus in two instances, one at Melton Mowbray and one near Cambridge, I found that the principal source of nuisance was manure making, and at two offensive establishments, one near Portsmouth, I found that swine were being kept in a most filthy condition, and fed, in part at least, upon the blood and offal of the knackery. On Effluvium-Nuisances, by Dr. Ballard.

Most of these sources of effluvia are of the nature of filth nuisances, and like those effluvia which proceed from places where animals are improperly kept, or from slaughter-houses, must be regarded as calculated to injure the health of persons much exposed to them. Even casual exposure may give rise to nausea and temporary functional disturbance arising from the impression made upon the senses. Nevertheless it is quite practicable to carry on this offensive trade in such a manner as not to be a nuisance, or with only a minimum of offensiveness. In so far as they are filth-nuisances, they are injurious to health. Mode of preventing nuisances.

1. The premises should be sufficiently isolated, as recommended in the instance of slaughter-houses. 2. They should be sufficiently capacious, not only for the ordinary amount of business carried on, but to meet the exigencies of season and epizootic outbreaks, by affording accommodation, without inconvenience to the operations of the knackery, for as many dead animals as are likely under any circumstances to be brought in. 3. The arrangements of the buildings should be approximated in principle (*mutatis mutandis*) to those recommended in the instance of slaughter-houses, *i.e.*, (*a*) The pound should be duly paved, well drained, well ventilated, well lighted, kept very clean and periodically limewhited; *b.* the slaughter-house should be firmly paved on concrete with an impervious and preferably jointless pavement, properly sloped to a channel leading to a properly trapped drain inlet furnished with due arrangements for arresting solid matters; the walls should be rendered impervious by covering them evenly with cement to the height of at least 6 feet from the floor, and all woodwork to the same height should be covered with sheet zinc; and the slaughter-house should be well ventilated and lighted, preferably from the roof; *c.* the yard should be capacious, well and evenly paved, and duly drained, and provided with open sheds for the protection of carcases deposited there from the rain and direct rays of the sun. 4. The business should be conducted in as cleanly a manner as possible. *a.* No dead animals should remain undealt with upon the premises longer than 24 hours, at any rate in the summer time, and, at all seasons, the carcases should be disposed of before they undergo putrefaction. Carcases which may be in a state of putrefaction should not be received at all; they should be buried; or if received, or if they should chance to become putrid after reception, should be dealt with otherwise than in the manner customary in English knackeries.* *b.* Proper impervious

* One mode of dealing with such putrid carcases might be to flay them and divide them sufficiently, to deodorise the skins by the application to the fleshy side of an effective deodorant, and, after similarly deodorising the flesh to deal with the pieces into which the carcass has been divided in the mode which I have seen employed in a knackery near Paris. In this establishment there was in use a strong iron cylinder capable of containing the carcases of two or more horses. Into this cylinder steam was introduced under pressure. After a short time the whole of the soft parts were converted into a pulp, which was run off into trenches to solidify and dry, and the pulp was subsequently dried and pulverised for the manufacture of manure. The bones were discharged clean and ready for the use of the bone manure maker.

On Effluvium-Nuisances, by Dr. Ballard.

covered vessels or barrows or carts should be provided for the reception of viscera, skins, and bones or manure prior to their being further dealt with, or for conveyance to the parts of the premises at which they are to be dealt with, or for conveyance from the premises elsewhere, and such receptacles should be duly used. There should be no such thing as a dung-pit or dung-shed; everything of the nature of refuse should be removed daily from the premises in the covered receptacles in which they are first placed. *c.* As much care as possible should be taken to collect all the blood so as to avoid its entrance into drains. With this object it is desirable that carcases brought in dead should not be dealt with while they are yet warm, nor until it is probable that the greater part of the blood in the vessels has coagulated. *d.* The floor of the slaughter-house should be kept constantly swept up and the garbage removed, and at the end of each day's work it should, with the walls to the length of the impervious portion, be well washed with water, of which there should be an abundant supply stored at a sufficient elevation to allow of the use of a hose. The inner walls should be kept sweet by periodical lime-washing. *e.* The boiling of the flesh and fat should be carried on with due precaution for the avoidance of the escape of the resultant offensive vapours into the external atmosphere. The means of attaining this object are the same as those which will be mentioned under the heads of "flesh, tripe, and trotter boiling" and "fat melting." *f.* The issue of offensive vapours from the meat or intestines when removed from the boiling pans, may be obviated by throwing them at once from the pan into a trough of cold running water for a few minutes. *g.* The liquor in the pans should be allowed to become cold before being run off into drains.

Part III. On Effluvium Nuisances arising from other businesses in which Matters of Animal Origin are dealt with.

Part III.

On Effluvium Nuisances arising in Connexion with Branches of Industry in which Animal Matters or Substances of Animal Origin are principally dealt with.

The Curing of Bacon.

Establishments visited.

Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Jan. 19, 1876	Williams - -	Bedminster -	Slaughtering of pigs.
„ 21 „	Skull - -	Bristol - -	Do., rendering of lard, boiling chitterlings, &c.
„ „ „	Dole - -	Do. - -	Do.
„ 29, 1877	— Day - -	Reading (Cross Street).	Do.
„ „ „	— Day - -	Reading (Munster Street).	Do.
„ „ „	Thomson - -	Reading - -	Do.
„ 30 „	Thomas Harris -	Calne - -	Do., gut scraping.
„ „ „	C. Harris & Co. -	Do. - -	Do.
Mar. 22 „	Humphrey and Evans.	South Shields.	
„ „ „	Nicholson. -	Do.	

The establishments at which the making of pork into bacon is carried on vary very much in size and commercial importance. For example, at Calne there are two very extensive establishments, viz., that of Thomas Harris and that of Charles Harris & Co., where as many as 150 pigs are killed in one morning for conversion into bacon, and at Cirencester there is a similar large establishment, all of which I have visited. At Reading, on the other hand, where a large quantity of bacon is made, we have examples of a large number of small establishments, where only four or five or even fewer pigs are killed for bacon at one time, and where pork butchers engaged in this trade perform part of the process for other persons, such as grocers, who perform the earlier parts of the process on their own premises.

Varying size of curing establishments.

Persons who, as a matter of trade, make bacon also keep pigs, some for fattening, but some only for fasting prior to slaughter; and after slaughter not only cure the bacon, but render the lard, prepare or cook chitterlings, and commonly scrape the small intestines for the preparation of sausage skins. Hence an effluvium-nuisance proceeding from a bacon manufactory is not necessarily one arising directly from any process of actual curing, but may be due to one of these associated circumstances of the trade. The work carried on at a bacon-making establishment commences with the slaughter of the pigs. After slaughtering, the hair is singed off and the singed carcass is washed and scraped to remove the burned hair. The carcass is then disembowelled and dressed, salted down in appropriate cool chambers, and after the salt has been washed off and the surface wiped dry and dusted over with pea-meal, the salted meat is hung up in appropriate chambers to be dried and smoked. The brine which runs from the meat when in salt is collected in tanks, and when of no further use is disposed of in the way that sewage is usually disposed of.

General description of the trade.

I have already said all that is necessary about the process of slaughtering, including the removal of the viscera and dressing of the carcass, in a former part of this report; and other processes will be treated of when I come to the trades of fat-melting and gut-scraping, and boiling of various articles of food (such as tripe, trotters, &c.), so that I shall confine my description to the two processes of singeing and smoking. There are matters of sanitary interest connected with the salting of the meat, but they have nothing to do with the immediate subject of this report. The singeing off of the hair is performed in various ways in different establishments. In small establishments it is often performed in a very rough manner, namely, by surrounding the carcass or several carcasses with straw and then igniting the straw. Wherever I have seen this done in England it has been done in an open yard. Another method consists in applying to the carcass the flames from a coal fire. For the application of this method a special apparatus is requisite, and the form of the apparatus differs in different establishments. At Skull's establishment in Bristol, the carcass is hoisted by a pulley and counterpoise into a sort of chimney shaft supplied with flame by means of two coal fires at the lower part, the whole arrangement being placed on a platform or floor just above the base of the floor on which the pigs are slaughtered. The shaft terminates above in a chimney, the top of which is about 30 feet from the ground. Fig. 1 is a rough sketch of this arrangement.

Operation of singeing,

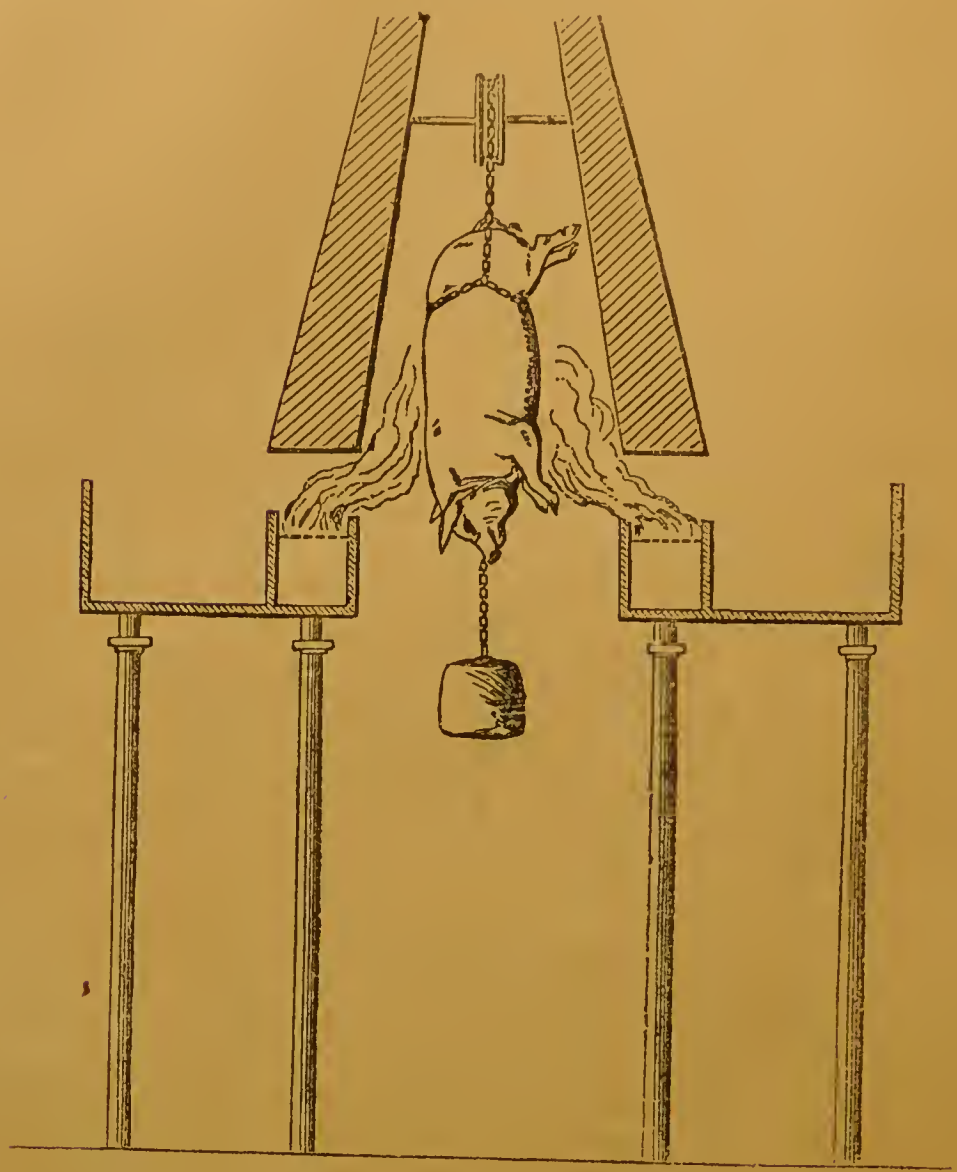
with straw,

by flame of a coal fire,

At Harris', in Calne, Denny's Patent Pig-singeing Furnace and Apparatus are in use. The carcass, run out head downwards on a rod from the killing place, is taken down upon a fixed bench, where it is suspended horizontally upon a waggon running upon a narrow rail or tramway forming one of four similar arms in a revolving apparatus which allows another carcass to be affixed while the previous one is in process of

singeing. This rail corresponds with another at the upper part of the furnace. By this the carcass is then run into a chamber into which the

Fig 1.



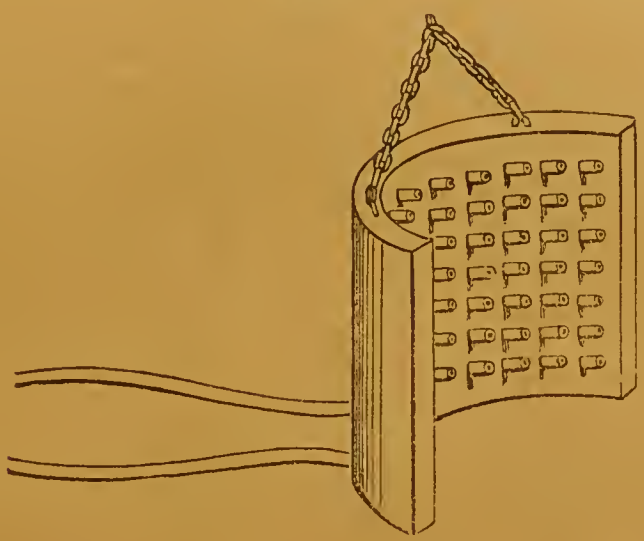
flames pass from two large fires, one on each side. The chamber, during the time the carcass is in it (which is not longer than about 25 seconds), is enclosed in front by a pair of iron doors which, when closed, leave a space of several inches above (where the rail passes in). From this space during the singeing, some of the smoke from the burning hair, together with a little flame, issues into the interior of the building, and finally gains exit by the openings in the roof at a considerable elevation. The greater part of the smoke, however, passes off by the furnace chimney. The accompanying plans, Plates 1, 2, and 3, show the arrangement of the furnace and revolving apparatus. The carcass being run out and a fresh one being run in from the revolving apparatus, the singed carcass is taken down upon a revolving table and is again suspended head downwards upon another bar which conveys it to the washing place. When the carcass is run out, smoke from the singed surface is given off freely into the building, but its issue is checked within a very few minutes by suspending the carcass over a tub and throwing cold water over it preparatory to scraping.

In other establishments the flame of burning gas is used for singeing the carcass. Even in small establishments this may be seen, as for

example at Thomson's at Reading. At this establishment the singeing with the gas apparatus is performed under an open shed in the yard of the premises. The apparatus, of which Fig. 2 is a rough sketch, consists of an iron shield in the form of a segment of a circle. It is about 2 feet high, and 2 feet diameter. The thickness of the shield contains a hollow space, into which, on the convex side, gas is introduced by one tube while air is driven in by means of a fan or blower through another larger tube. The mixed gases issue by a series of about 100 jets on the concave side, and, after lighting the mixture, the carcass is suspended near the concavity, and singed all over by varying the elevation of the shield by a pulley on which it is suspended, and turning the carcass round so as to expose all parts in succession.

by flame of gas.

Fig. 2.



At Dole's establishment at Bristol a more elaborate form of the same arrangement, constructed by Mr. Miles, engineer of Bristol, is in use, (Plate 4.) It is set up within the part of the building appropriated to slaughtering and dressing. It consists of two shields of similar construction to that just described, the concavities facing one another, and the shields being of such length and so provided with hinges at the lower ends as to be capable of enclosing the carcass between them. To introduce and remove the carcass the shields are opened out like scissors from the hinges below, and the carcass is run in or out suspended head downwards from a rod above. By this arrangement the singeing is much expedited (80 carcases can be singed per hour), the singeing being effected all round at one time. Practically, however, Mr. Dole finds it sufficient to light the gas from one shield only, and if the side distant from the shield is not sufficiently singed the carcass is turned round for a few seconds, so as to expose that side to the direct action of the flame. The smoke from the singed carcass issuing from the top of the apparatus, together with that from the carcass after removal, passes out by the louvred openings at the roof of the building.

Drying and smoking.

The drying and smoking are effected in chambers provided for the purpose, sometimes of brick, or partly of brick and partly of wood, within which are rods and hooks, upon which the sides of bacon, ham, &c. may be suspended. These chambers have openings above, either louvre openings or trap doors, by which smoke may issue, and by which the heat may be regulated. The heat requisite is about 95° Fahr. It may be supplied (if the bacon is not to be smoked) by a fire of coke or anthracite coal in a brazier, or moveable fire-grate placed in the

centre of the floor; but if the bacon is to be smoked, the heat of burning wood or sawdust is employed, either alone or in conjunction with the fire above mentioned. The wood or sawdust used are preferably those of elm or oak. The erections in which this process is conducted vary in size and elevation, according to the amount of work done at the establishment. In large establishments, like those at Calne, the smoking chambers are very lofty and capacious, but at small establishments like some I visited at Reading, they were small and low, say 8 feet high and wide, and four feet from front to back, and were situated in the back yards of the houses.

Sources of Effluvium-nuisances,

Effluvium-nuisances may arise at bacon-curing establishments out of the associated trades carried on in them, such as pig-keeping, slaughtering, rendering of fat, boiling of chitterlings, &c., or gut scraping. But all these sources of nuisance will be considered under the heads of these several trades or processes. The only other nuisances which I have heard complained of seriously have been those arising from the singeing and smoking, and the disposal of the waste brine and other matters from the curing house. But in this last case other liquid matters were discharged with the brine, and probably had much to do with the nuisance. The case was one of defective drainage, the liquid refuse from the establishment having been discharged upon some neighbouring waste land, where it putrified, and became very offensive.

from singeing,

The offensive pungent smell from singeing, however, has sometimes been rather grievously complained of, and at Reading, in one instance, the local authority had occasion to deal with it. The smell is that of burning hair. Under favouring circumstances, as where the operation is performed in an open yard, surrounded with tall buildings, the nuisance has extended to a distance of 50 yards, and has been especially complained of in sultry close weather, when little wind has been stirring, and the smoke has thus been confined within a limited space. Under these conditions it has been described as "nauseating," and as producing "sickness at the stomach," but no more serious injury to health has to my knowledge been ascribed to it. Where straw has been employed for singeing there has been in addition the nuisance from the smoke, and from blacks or portions of charred straw falling about in the neighbourhood. This last form of nuisance has led the Reading Sanitary Authority, on the complaint of butchers, who asserted that the blacks rendered their meat unpresentable, to prohibit singeing at the public abbatoir. It is obvious that the nuisance from singeing is greater the slower is the method adopted. The more rapid the process, and the shorter the time which elapses between the singeing

from smoking,

and the washing and scraping, the less is the nuisance occasioned. The rather irritating vapour and smoke issuing from smoking chambers has also been occasionally made subject of complaint. In both these respects small establishments have, so far as I can learn, alone been complained of, the reasons being the comparative slowness of singeing, from the lack of due appliances for rapid work, and the low elevation at which the smoke has issued in a closely built-in neighbourhood. At Calne, and at Cirencester, and at Bristol the smoke has been no nuisance, having been discharged under circumstances favourable to its speedy diffusion.

Mode of preventing nuisance,

The remedies applicable for preventing or minimizing the nuisance from singeing are, first, the use of appliances for speedy singeing, and washing with cold water as quickly as possible after the singeing has been effected. In the close parts of towns, singeing ought not to be effected by means of straw; singeing with gas or a well planned fire

arrangement, as at Calne, and at Skull's and Dole's establishments in Bristol, is much preferable in view of speed and readiness of disposing of the smoke without producing nuisance. The interval elapsing between these two processes of singeing and washing may be abridged by good mechanical appliances. Hence it is better to singe in a position of the carcass which shall not require to be altered for the purpose of washing down. A carcass suspended head downwards from a rod, on which it may be made to travel, is on this ground best singed in this position, and then it can be made to travel on in the same position to the place for washing and scraping, and be washed down with cold water immediately; only a second or two intervening between the two processes. Without invidiously comparing establishments which are not comparable the one with the other, it appears to me that the plan adopted by Dole and by Skull at Bristol may, in this one respect, be, in some situations, preferable to that adopted at Calne. Secondly, when the smoke is produced in an area surrounded by tall houses, and issues at such a level as to enter at the windows of such houses, an effectual remedy will be found in performing all the singeing and subsequent washing within a building provided with a tall chimney shaft, so arranged as to carry off the smoke and discharge it at an elevation above the tops of adjoining houses. A similar provision (modified for the requirements of the process) to a low smoking-chamber or smoke-house would prevent any nuisance from this source.

from the singeing.

from the smoking.

At South Shields, at Newcastle, Gateshead, and probably in some other places, American pork is dried for conversion into bacon. The pork arrives salted, and is sometimes more or less tainted. The preparation consists first in soaking it for a night in warm or cold water to remove the excess of salt, and then rapidly drying it in a closed chamber heated by a coke fire in the centre. The windows are then opened and the bacon is exposed for some days to a current of fresh air. Some hams are hung subsequently in a dark room to obtain a blue mouldiness on the surface, or a "bloom," which enables them, it is said, to be sold as Cumberland hams. This process may give rise to serious nuisance if conducted in an improper place and without proper care to prevent nuisance. Dr. Spear mentioned to me an instance of this nuisance which came under his observation at South Shields. The process was conducted in a wholly unventilated cellar immediately beneath an inhabited room, the inhabitants of which complained bitterly of the offensive steam and animal effluvia which entered their room through the loosely boarded floor. The nuisance came under his notice in consequence of a death of a child from diphtheria in this room. The parents, although poor, were respectable people, had no acquaintance in the neighbourhood so far as Dr. Spear could ascertain, and the child had not been out of the house for some days before her illness. The house (a single room) was, he says, in a manner, isolated, was remarkably clean, and in no way exposed to drain or privy emanations, and the water supply was beyond suspicion. Dr. Taylor, the Deputy Medical Officer of Health for Liverpool, informs me that his trade has occasioned nuisance in Liverpool from the discharge of the warm washing-water into the drains, the effluvia rising up through the traps of neighbouring house drains and from the street gullies. Such a trade as this should only be conducted in such a way as to provide against the effluvia becoming a nuisance, or entering inhabited houses.

The Curing of Fish.

Establishments visited.

Date.	Names.	Locality.	—
Nov. 4, 1875	Cushaw - -	Bethnal Green.	
„ „ „	A colony of fish curers.	Faith Street, Bethnal Green.	
Dec. 11 „	Do. - -	Gun Street and Martin Street, St. George, Southwark.	
May 30, 1876	Twemlow - -	Salford.	
Dec. 8 „	Butty - -	Hull.	
„ „ „	Rowntree - -	Do.	
„ „ „	Pickering - -	Do.	
„ „ „	Baynton - -	Do.	

Localities and size of establishments.

Fish curing is a trade largely carried on in some towns. In London there are complete colonies of fish curers in some of the small streets in Bethnal Green and St. George's, Southwark. In these latter places the trade is confined to the costermonger class of the population, who cure herrings, sprats, and haddocks, each in their due season, carrying on the work partly within their dwellings and partly in the small back yards adjoining their houses. The narrow yard space between the houses in one street and those in another parallel street forms, in some such instances, one elongated narrow space occupied by little curing or smoking houses, nearly every house yard being thus furnished with means for curing. In Hull, on the other hand, and in some other places as London, Bristol, &c., there are comparatively large establishments, in which a considerable capital has been sunk, devoted to this trade. So extensive is the trade in Hull that the Sanitary Authority has thought it expedient to frame byelaws for its regulation in such a way as to avoid nuisance.

General description of the trade.

Herrings and sprats arrive at curing establishments packed with salt in barrels. Haddocks are purchased fresh for curing.

With herrings and sprats the first process consists in washing off the loose salt and scales, which, when washed off, are, in large establishments, placed in a heap or tub in the yard to be sold as manure. They are then well washed a second time in a basket by rotating the basket in a tub of water. They are then strung upon sticks about four feet long placed on a frame in the yard to drain, and when drained are transferred to the drying-house to dry.

The process of "kippering" herrings consists first in careful washing; the fish are then split open, the roes taken out (and sometimes sent away for preservation by tinning), and the fish are soaked for about two hours in strong brine, washed again, drained, and then smoked in the drying-house.

In curing haddocks, the fish are split open and gutted and the heads are cut off; they are then washed and scrubbed with a brush, soaked for a sufficient time in brine, and then hung up in the drying-house,

These preliminary operations are sometimes carried on within dwelling-houses, but in large establishments in properly constructed rooms furnished with proper arrangements for washing and scrubbing ranged against the windows or along a side of the room. The refuse (heads and guts) is occasionally put in a heap in the roadway to be removed

by the public scavenger, but mostly I have found it set aside in tubs or tanks for removal by persons who collect it for manufacture into manure.

Drying and smoking.

The drying or smoking is effected in erections provided for the purpose. Where the trade is carried on, as in Bethnal Green, by persons of the costermonger class, these erections are small, and rather than anything else resemble long cupboards about 10 feet to 12 feet high, and about 4 feet square in their horizontal dimensions, constructed of brick below but of wood above, closed in with a door or sometimes only with some sacking, and having sufficient openings in the side or roof to allow the issue of superfluous smoke. In more important establishments, the drying-houses are constructed of brickwork entirely or only to the height of six or seven feet from the ground and the rest of wood. They rise to the height of 12 to 25 or 40 feet and are very capacious. At Cushaw's, in Peel Grove, Bethnal Green, each compartment of the drying-house will accommodate as many as 26 barrels of herrings of 600 to the barrel. The drying-houses have means afforded above for the issue of smoke, these means consisting either of louvres or of trap-doors or glazed skylights. When it is desired merely to dry the fish, coke fires are introduced into the space below where the fish hang, but when it is desired to smoke the fish, wood or sawdust is burned. The wood used is either oak, beech, or horn beam, and the sawdust either oak or mahogany, a little deal sawdust being used (in some small establishments more than a little I expect) to assist in obtaining a sufficient ignition. Until the fish is "skin dry" the means of ventilation near the roof are kept open, but when the surface of the fish is dry enough they are closed up. In some establishments where the ventilation provided is merely the spaces between the unpointed tiles of the roof, and in other establishments where other special means are provided, I am told that no alteration is made throughout the process. The practice in this respect, then seems to vary in different establishments. Herrings put into the drying-house at 6 p.m. are ready to be taken out at midnight or at 1 a.m.

Source of effluvium-nuisances.

The nuisances which arise from fish-curing establishments depend upon the offensive odour which may proceed from the undue retention of refuse, or from a filthy mode of conducting the business, or upon the issue of irritating wood smoke from the drying-houses. Mr. Bately, the medical officer of health at Great Yarmouth, where fish curing is largely carried on, tells me that the only nuisances which arise there are similar to those from other trade premises, where refuse and filth are allowed to accumulate, and that nuisance from the wood smoke is rarely complained of. The authorities there have not considered it requisite to make special byelaws for the regulation of the business; and at Hull, the byelaws enacted mainly provide for due cleanliness and speedy removal from the premises of refuse and garbage. In London, the nuisance from the wood smoke has been complained of in Bethnal Green, but the Sanitary Authority there has not seen its way to any serious action in respect of it. Nevertheless the pungent smoke must, to say the least, be annoying when it enters the windows of adjoining dwellings. Ill conducted establishments if they pollute the air with effluvia from decomposing fish refuse, must on general principles be held to be injurious to the health of persons much exposed to such effluvia.

Mode of preventing nuisances.

The obvious remedy against the first class of nuisances from fish curing lies in scrupulous cleanliness of all parts of the premises and of the vessels and plant used in conducting the business, and in proper disposal of the refuse and garbage. The yard and floors of all parts of the premises should be evenly paved and duly sloped to a properly constructed drain inlet. The inner walls should be periodically limewhited, and if splashed, as they are apt to be when the washing vessels

are placed against them, these dirty parts should be scraped clean before limewhiting. But it would be still better if, in these parts, the wall were covered with a smooth impervious material such as cement or glazed tiles, so as to permit of the surface being duly washed at the end of each day's work. At the close of each day's work the whole floor, together with the tubs and other vessels used in the process, should be thoroughly scoured and cleansed. I have seen several kinds of paving in use in curing houses, but the best of all has been made of cement. Such a paving may be seen at use at Butty's establishment, in Hull, where the arrangements generally are very commendable and contrast favourably with those of some other establishments in the same street. Cleaning-up, however, ought not to be left altogether to the end of the day's work. A proprietor may very easily, if he pleases, make and enforce regulations for the workpeople, prohibiting the scattering of fish heads and guts upon the floor during their work. For the reception of such refuse proper vessels, made of some impervious material, should be provided; and, when they are full, closely fitting covers should be put on, and in this condition these offensive matters should be removed from the premises daily. The remedy against the smoke nuisance from the drying-houses is equally obvious. It consists in carrying up a shaft from the roof to such a height as that the smoke shall be discharged above the level of adjoining houses, and so arranged that this shall be the only means by which the smoke shall escape.

The Frying of Fish.

Establishments visited.

Establishments visited.

Date.	Name.	Locality.
At various times - -	Various establishments -	London.

Description of the trade.

In very many parts of London, and in some large towns, fish is sold ready fried for the convenience of poor purchasers. The fish, mostly plaice, is fried upon the premises, and almost always in the open shop in which it is subsequently sold. The fat used in the frying is various, but I understand is mostly refined cotton-seed oil. The boiling of the oil, and the cooking of the fish in it, is carried on at all times of the day and evening. It is a petty trade, but, nevertheless, is a source of considerable nuisance in some neighbourhoods, the offensive smell of the

Extent and source of the nuisance.

oil boiling and fish frying spreading often, not only through the whole length of the street where the shop is situated, but sometimes into adjoining streets also. When the shop is situated in a street occupied by poor persons of the class who purchase such food, complaints of the smell are rarely, if ever, made; but passengers are annoyed by it, and so also are the tenants of houses of the better class who chance to reside in the neighbourhood. For it is not only in poor streets that such shops are to be found. There is, I believe scarcely a health officer in London who has not at some time been called upon by the authority under which he acts to advise as to an appropriate remedy for this

Mode of preventing of the nuisance.

nuisance. The difficulty in dealing with it lies in this, that the pan or fixed shallow iron vessel in which the fish is fried by a fire beneath, must be always open to view, and to allow of the necessary manipulation. The ordinary remedy suggested and adopted in a great many places has been the provision of a hopper above the pan, which hopper

is intended to catch the fumes as they arise, and to convey them by an opening above into some adjoining chimney. But for various reasons the remedy has not proved always very effectual; the faultiness partly consisting in the defective draught of the chimney, partly upon the hopper not being brought low enough or far enough forward over and in front of the pan, and partly depending on the fact that, the process being conducted in the open shop, the wind entering the shop, and draughts of air, interfere with the due operation of the hopper. A more effectual arrangement would be to conduct the operation in a closed outhouse, or other place where draughts of air could not so interfere, to bring the hopper well down and forward, and to close in the sides, having only the front part of the pan open for observation and necessary manipulation. The chimney of the fire should be so constructed as to obtain a good upward draught, and should be carried up above the roofs of adjoining houses.

Trade of a Fellmonger.

Establishments visited.

Date.	Names.	Locality.	Other Businesses or Processes conjoined.
Nov. 2, 1875	Byford - -	Bermondsey.	
„ „ „	Johnson and Bolsher.	Do.	
Dec. 18 „	Tanner - -	Plymouth - -	Leather dressing, tanning.
„ 22 „	Head - -	Stonehouse, near Plymouth.	Preparation of pelts for exportation to America, preparation of hake-liver oil.
Jan. 1, 1876	Nickols and Son -	Joppa, Leeds -	Leather dressing, tanning, glue making.
„ 19 „	Ball - -	Bristol.	
„ 20 „	Gunter - -	Do. - -	Leather dressing, parchment making.
April 1 „	Fitch - -	Melton Mowbray -	Leather dressing, tanning, glue making.
May 30 „	Hossell - -	Salford.	
Nov. 24 „	Windsor - -	Bermondsey -	Manufacture of skin mats.
„ „ „	Cordrey - -	Do.	
„ 28 „	Herron - -	Hereford - -	Leather dressing.
Dec. 4 „	Fenton - -	Glasgow.	
„ 8 „	Foster - -	Little Driffield -	Leather dressing, tanning, artificial manure making.
„ „ „	Nicholson -	Do. - -	Leather dressing, artificial manure making, manufacture of skin mats.

General outlines of the trade.

The legitimate and simple trade of a fellmonger consists in receiving the "skins" of sheep, and in preparing them for the use of the leather-dresser. He takes off the wool, which, if sufficiently long, he sells to the woolstapler, and he limes the skins, preparatory to sending them to the leather-dresser. Some fellmongers also, at the proper season of the year, convert the best skins into skin mats.

Kinds of skins received and dealt with.

Two classes of sheep and lambs' skins, chiefly, are received by the fellmonger, viz., fresh English skins from the butcher, or intermediately from the skin market, and dry foreign skins which come to him closely packed in bales. These two classes of skins undergo at his hands somewhat different treatment. Some fellmongers receive both classes of skins, others confine their trade to one class only. A few foreign skins which arrive moist, salted and rolled up, are dealt with like English skins. The following are the processes to which the skins are subjected to prepare them for the use of the leather dresser:

Mode of dealing with English skins.

1. *English Skins.*—1st. The first process consists in cleansing the skins from dirt and dung, blood, &c. They are beaten with a mallet to detach any firm masses of dirt, and are then soaked and washed in water. In some country places, where a stream of water runs through the premises, this washing is done in the stream, which is sometimes dammed up for the purpose. In Bermondsey, the skins are laid in a "poke" or tank, or pool of water having a shelving bottom. A workman, in high water-boots, stands in this and washes the dirt out of the skins, rubbing them and waving them about in the water. He then throws them on the stones at the brink of the pool to drain.

2nd. The second process is liming. When there is no wool on the skins worth preserving, the skins are laid in a pit containing milk of lime. But the usual practice now is to lay the skins wool downwards upon a bench and to lay on cream of lime with a brush upon the fleshy surface. When thus brushed over, the skins are folded lengthwise (the limed surface inwards).

3rd. The skins are then in the summer time hung up in the yard out of doors, or in the winter in a chamber a little warmed. This process serves to loosen the attachment of the wool, and when it is loose enough the skins go to the "pulling-house."

4th. The "pulling-house" is arranged with bins for different kinds of wool, and in front of them the workmen sit, each taking upon his knees a skin, from which he pulls off the wool with his hands and throws it into the appropriate bin.

5th. The skin denuded of wood is then termed a "pelt," and it is thrown into a pit containing milk of lime, where it remains until it is ready to go to the leather-dresser.

6th. When about to be sent from the yard the pelts are taken out of the lime pit, and are laid in a heap in the yard, ready for carting away.

Mode of dealing with foreign skins.

2. *Foreign Skins.*—These undergo a somewhat different process.

1st. Being hard and dry they require to be softened, and for this purpose they are first laid in a tank or pool of water for a period varying up to 40 hours. At Head's Yard, in Stonehouse, I saw them soaking in a tank above ground, through which a stream of water was made to flow constantly. At these works, I was told that they only require soaking about three hours.

2nd. The next process after the skins have been drained from the water is what is termed "burring," that is to say, removing from the wool the "burrs" (apparently the fruit of some plant) which stick in it. This is effected partly by the use of a machine, "burring machine," adapted for the purpose, and partly (or subsequently when necessary) by the hand labour of women, who pick out the burrs.

3rd. Foreign skins are not limewhited, but the attachment of the wool is loosened by the process of "tainting." The damp skins are hung up in a chamber which is warmed in the winter either by a small coke stove or by a jet of steam thrown into it. In the summer time the warming is unnecessary. In this chamber slight superficial change of the nature of putrefaction takes place. As soon as it is found that the wool pulls off readily, the skins are removed. This is a delicate process and requires to be very carefully conducted and watched, since in hot weather a little over retention in the "tainting oven" renders the skin utterly worthless to the leather-dresser.

4th. The wool is then either pulled off or scraped off. When pulled off, the short wool which remains after pulling is scraped off.

The remainder of the process resembles that in use for English skins.

The fellmonger before sending away wool to the woolstapler dries it by placing it on racks in a chamber heated by coke fires or by hot air pipes, or hot air is driven by a fan through the wool laid upon a wire trellis work.

Manufacture of wool mats.

Skin Mats or Wool Mats are made from the best and most woolly of English skins. The selected skins, as soon as they are received, are stretched upon a frame resembling a parchment frame, and being laid upon a table, the fleshy side is rubbed over by the hand with a solution of salt and alum to preserve them, and they are then folded and hung up until it may be convenient to dress them. When they are to be dressed, they are again placed on a stretcher and the fleshy side is scraped and a layer of whitening and water is brushed over. The skin then passes into a warm chamber to dry. When the whitening has become saturated with fat from the skin, the skin is again scraped, and this process of whitening and scraping is repeated until grease ceases to exude. Salt and alum in solution together are then rubbed in until the skin is thoroughly tanned. The skin is then well washed with soap and warm water preparatory to bleaching or drying. Bleaching is performed by placing the skins, while damp from the washing, in a chamber in which sulphur is being burned. The final process consists in scraping with appropriate instruments the inner side of the skin to render it all supple and of uniform thickness.

Fellmongering, an offensive trade.

A fellmonger's yard is sometimes a source of nuisance to the immediate neighbourhood, especially to persons residing in houses immediately abutting on it. I am told that in Bermondsey, where fellmongers' yards abound, it is a rare thing for complaints to be made. This is certainly not because they are always conducted in the best manner, but probably, in part, because the inhabitants of the district live by this and associated trades, and are so much accustomed to the effluvia that they cease to notice them. But as a matter of fact serious complaints have been made, and in one instance to this Department. For the most part, however, it is in country places that the fellmongering processes are most complained of, for it is in and about country towns that the trade is carried on in the roughest manner, and with the least regard to

tidiness and eleanliness ; moreover, in the country, it is searcely ever worth while to carry on the simple trade of a fellmonger, and the processes of leather-dressing are, either partially or fully, carried on in the same premises in conjunction with it.

Sources of effluvium nuisances.

The sources of nuisanee from a fellmonger's yard may be any of the following ; viz. :—

1st. The reeeption of raw skins from the skin market or from slaughter-houses, and their transferenee from the carts. When the skins are not absolutely fresh, short of such an amount of deeomposition as would render them worthless to the leather-dresser, they may, espeeially in the summer time, have a strong and offensive odour.

2nd. The ammoniaeal odour proceeding from a large number of lime-painted skins hanging up at one time in the yard.

3rd. The emptying and eleansing of the "poke" after it has been in use for a long time.—Dr. Parker, the late Medical Offieer of Health for Bermondsey, tells me that he has found this the prineipal source of nuisanee in fellmongers' yards.

4th. The waste lime taken from exhausted lime pits. This eontains more or less wool and animal matter, and when retained on the premises in a heap is apt to emit a more or less strong ammoniaeal odour.

5th. The general mixed offensive odour proeeeding from a yard whieh is badly or imperfeetly paved and drained and where due cleanliness is not observed.

6th. When the skins are washed in a flowing brook or stream or the liquid refuse of the yard is allowed to flow into the brook, this (which may be an offenee under the Rivers Pollution Aet) may become an offensive nuisanee below the works, espeeially if a large trade be carried on, and when the lower water is disturbed and agitated, as for instanee, by a water-wheel.

In Mr. T. W. Keate's evidenee given before the Seleet Committee of the House of Commons on Noxious Businesses in 1873, he only alluded to the first and fifth of these sources of nuisance. His report to a eommittee of the Metropolitan Board of Works, whieh was laid by Mr. C. Legge before the Seleet Committee, eontains (Q. 1863) the following passage : "There is in my opinion nothing inherent in this trade whieh "eauses it to be a noxious trade, nor eould any nuisanee arise from it, if "it were always earried on with the eare and eleanliness whieh are quite "within the reaeh of the manufaeturer. The only danger of nuisanee "would be from the reeeption of deeomposed skins from the market or "from the butchers, or from allowing skins to lie and beeome deeom-"posed in the yard ; but from what I saw in the different yards, and "from what was stated to me, I eonelude that sueh a state of things is "easily avoidable and could only arise from earelessness or negleet." In his personal evidenee (Q. 745) he said, "If the trade is badly "carried on ineonvenienee may arise, as a matter of eourse ; bad odours "may eome from a plaee like that, but that is entirely the fault of the "persons who are carrying on the trade ; there is nothing neeessarily "arising in eonneetion with the trade." This is nothing more than may be said of almost any offensive business, and so far I agree with him.

How far injurious to health.

I have not been able to aseertain from Dr. Parker, who has had a large experience of the trade in Bermondsey, nor from other medical men and medical offieers of health in the eountry whom I have interrogated upon the subjeet, that any distinct ill effeet upon the health of

persons living in the immediate vicinity of fellmongers' yards has been observed by them. Nor have I been able to ascertain that septic diseases have been noticed to occur with exceptional frequency in their neighbourhood, or with such frequency as to attract a health officer's attention. Nevertheless, a filthily-kept fellmonger's yard in a populous neighbourhood occasioning, as it necessarily must, a septic condition of the atmosphere about the works, is calculated (on general principles already enunciated) to be injurious to the health of the population most exposed to its influence. On Effluvium-Nuisances, by Dr. Ballard.

The trade of a fellmonger is not necessarily a nuisance. At Nickols' premises at Joppa, Leeds, where a very large number of English skins are dealt with weekly, and at Plenty and Co.'s in Bristol, where an equally large trade is done in foreign skins, the processes are all carried on in the best manner, and so far as I could learn without occasioning the least suspicion of nuisance. But at both these premises all are carried on within closed buildings. Slightly offensive skins must at times be received at fellmongers' premises; they cannot always be expected to be as free from odour as they are when newly taken from the carcase; and this is especially the case when the skins come from a distance and have to pass through a sale yard before they reach the fellmongers. Both in respect of the first and second sources of nuisance, there arises an advantage when the processes are not carried on in an open yard, as they commonly are in Bermondsey, but in covered and close buildings; and as respects the first, particularly, it is worthy of practical consideration whether the offensiveness of the skins might not be lessened, without injuring them for the operations of the fellmonger, by the application of some antiseptic, such as carbolic acid solution, to the fleshy surfaces before their removal to the yard. As regards the third source of nuisance, it does not appear from what I have observed of the mode in which the process is conducted in various works I have visited, that it is at all a necessity to use the same water in the poke repeatedly day after day for a lengthened period. It should be changed once a day at least, and in the summer time, twice a day. In some country towns I have seen running water used for soaking and washing English skins. I may instance Ball's yard in Bristol, where the Malagold stream is used for washing the skins; and Nickols' premises in Leeds where the water which runs through the washing tanks is pumped up constantly for the purpose. At Head's yard in Stonehouse the tanks for soaking and cleansing foreign skins are supplied with a constant stream of fresh water. The cost of water for the poke, if obtained from a town supply by meter, may be in some cases a sufficient inducement to neglect daily cleansing of the poke and daily renewal of the water. The obvious remedy for the fourth source of nuisance is the emptying the waste lime at once into covered carts for removal. The remedy for the fifth source of nuisance is equally obvious. It consists in good impervious paving properly sloped in all parts of the premises, good drainage, and scrupulous cleanliness. The yard should be kept constantly swept up, and the interior of the buildings and walls should be periodically limewhited. Unfortunately the traditions of the trade do not favour such scrupulousness. The trade is rather regarded as an essentially dirty one, and little pains are usually taken to make it otherwise. However, to those who may wish to see what good arrangements may effect for the prevention of nuisance, I recommend a visit to the two model establishments already mentioned. The sixth source of nuisance is to be obviated by intercepting the liquid refuse and by using one of the known methods of purifying sewage before it is allowed to flow into the stream or into a town sewer communicating directly with the stream. Modes of preventing nuisances.

Leather-Dressing and Parchment Making.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 9, 1875	Bevington and Son	Bermondsey.	
„ 18 „	Tanner - -	Plymouth -	Fellmongering, tanning.
„ 22 „	Head - -	Stonehouse, Plymouth.	Fellmongering, hake-liver oil making.
Jan. 19, 1876	Plenty & Co. -	Bristol.	
„ 20 „	Gunter - -	Do. - -	Fellmongering.
April 26 „	Turney Bros. -	Nottingham.	
May 30 „	Hossell - -	Salford - -	Do.
June 1 „	Nickols and Son -	Joppa, Leeds -	Fellmongering, tanning, glue-making.
„ 2 „	Clark and Thackray.	Newlay - -	(Calf skins) glue-making.
Nov. 24 „	Beach and Son -	Bermondsey -	Manufacture of skin mats.
„ „ „	Godman - -	Do. - -	(Calf skins).
„ „ „	Joseph Sharpe and Sons.	Do. - -	(Seal and horse skins).
„ „ „	James Garnier -	Do.	
„ 28 „	Herron - -	Hereford - -	Fellmongering.
Dec. 8 „	Foster - -	Little Driffield -	Fellmongering, tanning, artificial manure making.
„ „ „	Nicholson -	Do. - -	Fellmongering, artificial manure making, flesh and bone boiling.
„ 20 „	Turney Bros. -	Stourbridge -	Chamois leather making.
Mar. 14, 1877	Evans - -	Sowston, Cambridge.	(Chamois leather), fellmongering.
April 24 „	McRae - -	Mitcham - -	(Chamois leather and buff leather).

Definition of the trade.

In Bermondsey a distinction is drawn between a tanner and a leather-dresser. The former receives raw bullock "hides" and prepares and tans them; the legitimate trade of the latter is to receive "pelts" (sheep skins deprived of wool and limed) from the fellmonger, as well as horse skins, seal skins, calf and goat skins, and to convert them by a process of "tanning" or "tawing" into light leather. In country towns it is not unusual to see tanning and leather-dressing conjoined and carried on in the same premises; and then the manufacturer is generally designated and calls himself a "tanner." Under similar circumstances fellmongering is often also conjoined, so that the leather-dresser prepares his own pelts. The division of labour which is observed in Bermondsey is, for the most part, only practicable in large towns. When a leather-dresser, besides receiving "pelts," also receives calf skins, horse skins, and goat and seal skins (as is sometimes the case), the first part of the process, that is the liming and scraping off the hair, resembles in most respects the similar process to which sheep skins are subjected at a fellmonger's yard. Hence in describing the trade of a leather-dresser I shall confine myself to the part of the process which commences with the reception of the "pelts."

Process of leather-dressing.

They are first placed upon a curved board or "beam," where a man standing behind the beam scrapes them down on the fleshy side with a curved knife with two handles, so as to remove the connective tissue. This process is termed "breaking," and the parts removed are called "fleshings." At some works (as at Herron's in Hereford) a machine is used to perform this part of the work.

They then go back into pits containing milk of lime, first into lime pits previously used and hence weak, and then into newer lime pits which act more powerfully on the skins. The liming is continued altogether for 18 or 20 days.

The next process is to wash out the lime. This is usually done by putting the pelts into a tank of fresh water, where they are kept moving by beating the water by means of a sort of paddle-wheel, or else by putting them with water into a large revolving barrel having boards so placed within as to throw the skins over and tumble them about.

After having been well washed they are usually put into a solution of what is called "pure" (more correctly, it is said, spelt "puer"). This is dogs' dung, either collected by poor people in the streets for sale to leather-dressers, or more commonly collected at large kennels and sent to the leather-dressers in barrels. It is, when received from the kennels, a pultaceous looking material and stinks abominably. In large establishments, it is emptied into a covered tank underground, whence it is pumped up as required. When about to be used, a quantity, which varies in different establishments, is added to water in a tub or tank. Sometimes, as in the summer, it is sufficient to use cold water; but in the winter it is usual to employ the solution warm, *e.g.*, at a temperature of about 80° to 120°. Before putting the pelts into the puer tub they are commonly washed in some warm water. They remain in the puer solution until, from having a gristly feel between the fingers, they feel soft and supple. The time given for this varies in different works, with the temperature of the solution and with its strength, from 10 or 20 minutes to two or three hours, or even longer. Each manufacturer has his own peculiar practice in this respect. All, however, take care to remove the pelts as soon as the desired result is obtained; since, if they remain longer in the "puer," they are rotted and become worthless.

On removal from the puer tub they are again scraped down or "scudded," then washed in some warm water, and after this put into a tub containing bran and water. This is called a "dreneh." Here they remain about 48 hours; the contents of the tub undergo some fermentation, and the pelts come out whiter than when they were put in. At some works I have been informed that no puer is used; nothing but drenches.

English skins contain, especially about the neck and shoulders, a quantity of fat which, if left there, would interfere with the colour of the leather after tanning, so that it has to be removed. Sometimes this is done by cutting or slicing it off with a sharp double-handled knife, but sometimes after "puring," by subjecting the pelts to pressure in a hydraulic press. The fat runs out and is collected in a reservoir below for use by soap-boilers and others. Another method consists in subjecting the pelts to a scrubbing process by a machine patented by Mr. Turney, of Nottingham. The pelts are now ready for tawing or tanning, or to be prepared for exportation in barrels to America.

To prepare pelts for the American trade, they are next treated with dilute sulphuric acid, and subsequently with strong brine. After soaking for about 10 minutes in the acid they appear blown out and thickened, and the fibre of the pelts looks porous. But after having subsequently lain a few minutes in the brine they resume their former appearance. The pelts are then rolled up and packed in barrels with salt.

For "tawing" the prepared pelts are treated in a tumbler-barrel with salt, alum, yolk of egg, and water.

Tanning is usually effected by soaking in a bath of sumach or other tanning liquor, the precise method of applying these liquors varying in different establishments.

Sometimes skins are split by a machine which, while fixing the skin and pushing it onwards, cuts the skin with a knife into two layers. None of the other processes require any description here. They consist in drying, rolling, dyeing, &c. &c.

The "fleshings," &c. from the skins usually go to the glue-maker, but in some works are made into manure either on the premises (as near Driffield) or elsewhere. At Henry Turney's works in Stourbridge they are steamed in an open tank and subsequently pressed for the extraction of grease before being sent away for manure making.

Degree of nuisance arising from it.

The offensive smells that proceed from leather-dressers' establishments are rarely very serious, and they do not appear usually to extend to any considerable distance. Immediate neighbours, if there are any inhabited houses close to a yard, and passers by in the street, are alone likely to be offended by them for the most part. But I met with one instance of a very badly-conducted establishment where the nuisance was very great, and had been intolerable; a highly-offensive smell from the works having been a source of serious nuisance at a distance of a quarter of a mile.

To what extent injurious to health.

I have not heard at any time of any injury to health that has been occasioned, other than sometimes such temporary disturbances as any offensive smell may produce. In the instance above referred to, the effluvia gave rise to loss of appetite, nausea, and severe vomiting. I have failed to obtain satisfactory proof of septic diseases being more prevalent in the vicinity of such works than elsewhere. Yet, on general principles, an atmosphere loaded with septic pollutions from such works, when ill conducted, must be held to be unwholesome.

Nuisance may arise from the following sources, viz.:—

Sources of effluvium nuisances.

1. The "puring," if it be conducted in a part of the premises close to a public way or to inhabited houses, and then chiefly, if not solely, when, as in the winter, the solution is used warm. Under such circumstances the vapour which rises from the puer tub is exceedingly offensive and disgusting. It pervades the chamber or building in which this part of the process is conducted to such an extent that I myself have been very glad to make my escape; and it passes out of the building by the windows or louvre openings.

2. The discharge of the used up puer solution, drenches and other offensive liquids into the drains may also be offensive, if any open or imperfectly trapped inlets are in the vicinity. Their discharge into a flowing stream may cause more or less nuisance down the stream.

3. If the premises be uncleansed, badly paved and drained, and the business be conducted, as it too often is, in a slovenly manner, a generally diffused offensive smell is apt to pervade them, and to be wafted by the wind to houses and places in the neighbourhood.

In addition to these sources of nuisance, offensive effluvia may arise from other processes, such as manure making, carried on conjointly with leather dressing. I found this to be the case with some small establishments near Driffield.

Mode of preventing nuisances.

The remedies for these several sources of nuisance are as follows:—

1. Various attempts have been made to find a substitute for "puer" for softening pelts, but hitherto without success, or with only modified success. No leather-dresser, I am told, could undertake to produce a good specimen of leather without it. Nevertheless, several persons in a large way of business have told me that they have of late reduced its consumption considerably, and that by the judicious use of drenches much may be effected in this direction. If it be the case (as it seems, from what I have noticed, to be) that a cold solution produces the same effect as a warm solution, with the single disadvantage of a rather longer soaking in it being requisite, one source of nuisance might be in-

a great measure done away with. At Henry Turney's works, at Stourbridge, where the puring shop adjoins a public way, the nuisance is avoided by the closure of all windows on that side of the shop, and by carrying a wooden shaft 2 feet square from the ceiling of the puring shop, through all the upper rooms, to above the roof of the building.

2. The second source of nuisance is not usually a very serious one, and may be obviated by the addition of one of the well-known deodorants before the discharge of the waste liquors. At Herron's works in Hereford, where much nuisance arose from pollution of the stream with waste liquors discharged into it, these liquors are now collected, allowed to subside in a tank, and then purified with lime before being discharged.

3. As respects the third source of nuisance everything depends upon the general management of the yard and premises. As generally conducted, leather dressing is a very dirty trade; but there is no reason whatever why it should in any case be carried on in a dirty manner, so as to be a cause of offence to neighbours. Good and appropriate paving, (wood, being absorbent, is especially to be avoided) good drainage, the speedy removal from the premises of fleshings, and other refuse scraped from the pelts, and of the refuse lime from the pits, together with general cleanliness and avoidance of litter, and periodical scraping and lime-whiting of the interior of the buildings, would effect all that is necessary to render many of the premises, now a source of nuisance, sweet and inoffensive. With a view to show what can be done by careful arrangement in such matters when the proprietor sets his heart upon it, I append a description of a model leather-dressing establishment at Nottingham, belonging to Turney Bros., merely premising that I describe it as it was in the middle of the day when I visited it, without a word of intimation of my visit having previously been given. The tidiness of the establishment, in those parts where the dirtiest portions of the trade are carried on, contrasts in a very marked manner indeed with what is to be seen in the majority of leather-dressers' works. The trade here was commenced in a very small way only 15 years ago, and the buildings have been extended and added to, from time to time, as the trade grew. Only English pelts are received, and now, of such, an average of 18,000 are dealt with per week, 200 hands being employed at the works. The buildings are well built in brick, and on the four sides of a large quadrangular yard, which is well and firmly laid with square stone sets, and so sloped that water is readily carried off the surface. It was scrupulously clean, and there were no bits of skin or fleshings lying about it to render it untidy. Some fleshings prepared for removal were tidily laid in a heap. As Mr. Turney was crossing the yard with me he espied a little scrap or cutting of skin lying on the pavement, and (evidently automatically) he picked it up and threw it on the heap—a trifling incident this, but one that speaks volumes. The whole of the processes are carried on within the buildings, in spacious well-lighted rooms. The ground floors of the buildings are devoted to the wet parts of the trade, and to the engine-room, and the upper floors to the dry parts, and as store-rooms. All the ground floor rooms (with a trifling partial exception) are closely laid with blue bricks in cement upon a firm bottom of 6 inches of concrete, also made with cement in place of the ordinary lime. The floors are duly sloped for the effectual running off of any surface water, and are thus absolutely free from all sloppiness, and there are good drainage arrangements in every part beneath the surface. The supply of water is abundant, and there is no stint in its use. The pits in the room devoted to liming and washing the pelts are arranged down the sides, so as to leave a wide clear

Description of a model establishment.

passage between them. They are constructed in blue or red bricks (the latter only where the pits are circular), and these are laid with cement. In any case the edges of the pits are constructed with hard blue bricks so as to obviate the effects of wear and tear as far as possible, and to conduce to tidiness and cleanliness. The fleshing-shop is a long room on the opposite side of the quadrangle, having the splitting-room at right angles with it at its further end. Along each side of the central passage of the fleshing-shop is a slightly raised platform paved with stone, and on this the beams stand at which all the "fleshing" or "breaking" processes are performed. Between this raised platform and the wall there is again the usual paving of blue bricks, on which all matters scraped off the pelts fall, and remain until removed. Every part of the interior of the walls and ceiling of this room was clean and lime-whited. Some of the peculiar odour of "puer" was noticeable in the puring-shop, but it was not intolerable, and was imperceptible outside the open door. The puer tubs and the apparatus in the room were scrupulously clean, as well on the outside as within, and the floor (partly boarded) and pavement were clean and free from any dirty slop. Necessarily they were wet, but it was with water, for the running off of which good facilities are provided. What struck my attention most forcibly in these works was the perfect cleanliness, tidiness, and order which pervaded them throughout. Mr. Turney told me that they had no fixed time for cleaning up. It is always going on in all parts of the building. I noticed this even in the upper stories and in the store-rooms. He says that if any dust is made in moving goods about, the man or woman who makes it is bound at once to sweep it up. He believes this cleanliness alone costs him as much as 2*l.* per week. The fleshing-shop is thoroughly swept up every day, the workmen taking this duty in turns. The splashed walls opposite the beams (in most works I have seen, deeply encrusted with filth), are scraped three or four times a year, and every part of the interior of the buildings is lime-whited twice a year. The puring-shop is thoroughly cleaned every night, and once a week the puer tubs are scrubbed inside and out, and all the other apparatus in the room similarly thoroughly cleaned. He avoids litter very much by having had tramways laid down from one part of the ground floor of the building to another, along which the goods and refuse are conveyed in a trolly drawn by a donkey. When I asked him how he got his workmen to preserve such an unusual amount of cleanliness, he replied that it was a rule of the establishment, that the men had to subscribe a set of stringent rules on entering his service, and that they knew that, under them, an infringement was punished by immediate dismissal. He has thus the command of the best workmen, and even men from slovenly works speedily fall into the habits of tidiness which they see established here. With the permission of Mr. Turney I had photographs taken of the courtyard of the works, and of those parts of the premises in which the wet and usually dirty processes are conducted. I append these photographs to my report. They were taken under my own supervision, and represent correctly the condition in which I found the premises: a condition of tidiness and cleanliness which contrasts strongly with what is usually observable on the premises of leather-dressers.

Nickols & Son's establishment at Joppa, Leeds, shows the nearest approach of any works I have yet seen to the model works of Messrs. Turney. Both are well worthy of a visit.

Manufacture of chamois leather;

The manufacture of "*chamois leather*" presents peculiarities which call for its special description. The following is the process as I saw it

carried on at Henry Turney's, in Stourbridge. After the "pelts" have been fleshed and split, the inner or flesh-sides are taken for the manufacture. This portion is again passed through the splitting-machine in order to take off from the thicker parts so much as may suffice to render the skin of uniform thickness throughout. It is again limed, then washed, and afterwards put into a bran-drench. After removal from special process. the drench the skins are pressed nearly dry and then removed in bulk to the stocks, where they are beaten until they are soft with heavy tilt-hammers. When soft, oil (cod-liver oil in preference) is sprinkled on them and the "stocking" is continued, oil being added from time to time. The skins are then taken out and "aired off," *i.e.*, hung up in the room to dry. At other works, where there is a sufficient open space adjoining, the skins are in dry weather hung out in the open air. This "stocking" and "airing-off" are twice repeated, and the skins are then hung up in a chamber heated to about 120° by hot-air or steam pipes. An offensive vapour of acrolein * becomes thus diffused in the chamber. When the skins are dry they are "stocked" with oil again, and the beating is continued until the mass of skins becomes hot. They are then taken out and packed into a cask covered over with blankets and left to "ferment." The contents of the cask become very hot and an abundance of vapour of acrolein is given off. After the fermentation has continued for a time the skins are turned over and transferred to another cask. During this process acrolein vapour is largely evolved and affects very greatly the eyes of the workmen. The fermentation is continued now until heat ceases to be generated, and then the skins are allowed to get cold. The next thing is to get the oil out. With this object the skins are now thrown into hot water and from thence transferred to a powerful press. After leaving the press they are put into a "tumbler," or revolving barrel, with warm water and soda ash, and subsequently washed with cold water. Lastly, they are passed between rollers to press out all remnants of moisture and soapy matters and hung up in a loft to dry. The further processes have no interest in relation to this Report; they consist of various manipulations of scraping, pulling, stretching, &c., for the preparation of a saleable article. The oil pressed out of the fermented skins is known as "sod-oil." Before leaving the premises, it is customary to boil it in a pan heated by close steam in order to drive off any water it may contain. It is then sent away for use by curriers.

Special source of effluvium-nuisance.

The only special nuisance likely to arise in these proceedings would arise out of the diffusion of acrolein vapour beyond the works. Mr. Turney's works are so situated and arranged, however, as not to occasion any offence of the kind. But Dr. C. Fox, the Medical Officer of Health for Chelmsford rural district, informs me that the peculiar odour of fish oil and acrolein proceeding from some works in his district, which I was not permitted to inspect, is a nuisance at a distance of over 400 yards, when the wind is in a direction to carry the effluvia towards the public roadway. An effectual remedy for such a nuisance would probably be found in performing all the oily parts of the business within closed chambers, from which the offensive vapour might be drawn off and conducted through a fire before being allowed to issue externally.

Parchment-making.

In making *parchment*, the pelts, after liming and washing and fleshing as for leather-dressing, are split by the splitting machine, and the inner layer is taken for the making of the parchment. Knots are

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* The odour of acrolein may be familiarly illustrated by comparing it with that given off from an imperfectly extinguished oil-lamp.

made in the edges of this layer by tying up portions of lime or rubbish into balls all round, and by these knots the skin is stretched upon wooden frames. While on the frames the split side is scraped to render it even, and the skin is then "dubbed" with whitening and a strong solution of soda ash to get out the grease, and then it undergoes a series of sealdings with hot water thrown upon it out of a bowl, of scrapings, and of washings with whitening and water, and it is finally dried in a warm chamber. The sources of nuisance from such works are similar to those arising from leather-dressing, except the "puring" nuisance. Good drainage and cleanliness are very essential.

Tanning.—Preparation of "Pickers" Hides.

Tanning.—Preparation of "Pickers" Hides.

Establishments visited.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 9, 1875	James Barber Bros.	Bermondsey.	
„ 18 „	Ward Bros. -	Plymouth.	
„ „ „	Tanner - -	Do. - -	Fellmongering, leather dressing.
Jan. 19, 1876	Perry and Evans -	Bedminster, Bristol.	
„ „ „	Cox Bros. -	Do.	
„ „ „	Cox and Shepperton.	Do.	
„ „ „	Rake & Co. -	Do.	
„ „ „	Drake and Son -	Do.	
„ „ „	Vickary Bros. -	Do.	
„ 20 „	Cogan - -	Bristol - -	
Feb. 2 „	Reynolds - -	Warrington -	
„ „ „	Tinsley - -	Do.	
May 30 „	Butterworth -	Salford.	
June 1 „	Nickols and Son -	Joppa, Leeds -	Fellmongering, leather dressing, glue-making.
„ 8 „	Philbrick - -	Reading.	
„ 16 „	Ashworth and Percival.	Broughton, Manchester.	(Pickers hides).
„ „ „	Marsden and Wilkinson.	Do. - -	(Do.)
Nov. 24 „	Cox - -	Bermondsey -	
„ „ „	Ellis - -	Do. - -	Felt making.
„ „ „	S. Barrow -	Do.	
Dec. 8 „	Foster - -	Little Driffield -	Fellmongering, leather dressing, artificial manure making.

Definition of the trade.

The legitimate trade of a "tanner" is the conversion of bullocks' "hides" into leather.

Kinds of hides used.

Three classes of hides are in use:—1. Fresh English hides from the butchers or the hide market, which are known in the trade as "market hides"; 2. "Salted hides," mostly from South America, but also from other places; and, 3. Dried hides, either sun-dried, or dry-salted. They come from India, the Cape, South America, &c. They are known in the trade as "kips."

Some tanners receive two or more of these classes of hides, but the best tanners limit themselves to one class only.

Process of tanning.

In describing the process to which hides are subjected by the tanner, it will conduce to clearness to describe the process of tanning "market hides," and then to state the variations in treatment considered necessary in the case of the other two classes.

1. Of market hides.

1. *Market Hides.*—1st. The first process is "liming." A tanner has in his yard a series (or more than one series, according to the extent of his trade) of lime pits, which are worked in "shifts." They are usually series of three, the first being an old pit, the last being a pit of newly made milk of lime, and there is one intermediate. The hides to be limed are first laid one above another in the oldest of the three pits. It is called in the trade "backward lime," and is therefore the weakest (or the least caustic) of the shifts. Here they remain about two days. They are then removed into the intermediate pit, where they remain about three days; and then into the fresh lime, where they remain another three days at least. Some tanners prolong the liming process considerably beyond this period. The milk of lime is made with 6 to 10 bushels of lime to the pit. During this process the hides are "hauled" daily. This "hauling" consists in two men drawing out each hide separately with hooked instruments, and laying the hides one upon another at the edge of the pit, and then putting them back again. This is done to secure an even action of the lime. The exhausted lime-pit is then emptied, the water being run or pumped out, and the deposit laid in a heap in the yard until it can be taken away.

2nd. The next process is the removal of the hair. This is called "unhairing." Some tanners first draw the hides through fresh water, to prevent injury to the workmen's hands. Each hide is placed, fleshy side downwards, upon a semicircular iron beam, behind which the workman stands and scrapes downwards with a double-handled curved instrument called an "unhairer."

3rd. The hides are then washed in clean water and "fleshed," that is to say, the loose inner tissue is sliced off with a very sharp curved knife, the hides being placed on the same sort of beam as in previous process. The matters sliced off are called "fleshings," and are sent to the glue makers.

4th. The hide is then laid upon a table or bench and "rounded," *i.e.*, the shoulders and bellies are cut off to be separately dealt with, and the corners are removed, the small scraps leaving the premises for use by the glue-makers. The hide after this treatment is henceforward known as a "butt."

5th. The "butts" are put into clean water for a few hours to clean off some of the lime, and then, if it is intended to "dress" them subsequently, that is to convert them into "uppers" or soft leather, into the "graining" pit. This is a pit containing a solution of pigeon's dung, called "grainers." This tends to soften the material, as "puer" to soften sheeps' pelts. Sometimes water mixed with urine is used for the same purpose, or a weak solution of ammonia, and sometimes fowls' dung is used in place of pigeons' dung. The "grainers" are used cold.

6th. "Seudding" is the next process. The hides are replaced on the beam, and are worked over with a double-handled instrument like an "unhairer," so as to remove all superfluous water and dirt, and the small hairs are removed by skimming over the surface with a sharp knife used like a razor.

7th. Such hides as are to be split now undergo the process in splitting machines.

8th. The strictly tanning process is then proceeded with. The first part is called "colouring." For this purpose the butts are suspended upon poles by a hole made through the neck part, and are lowered into a pit or washer of old tan-liquor. They are raised and lowered again several times daily for about eight days. I have seen this process performed by causing the butts or kips to revolve in a barrel having holes in it, in

a tank of old tan liquor; the interior of the barrel being so arranged as to cause the contents to tumble over. The object is to colour evenly in all parts. The butts are then taken off the poles and go into the tan-pits. These are worked in "shifts;" they are known as "floaters" and "dusters." First they go into, say, four floaters in succession, which are pits of tan liquor of gradually increasing strength, and, after passing through these, being "handled" (that is to say, taken out and laid in again) about twice a week, they are removed to the "dusters." "Dusting" consists in laying the butts in liquor of the strength of about 25 degrees of the "barkometer," sprinkling some crushed bark over each of them, each pack being usually put into three or four such new liquors and remaining in each liquor for a week without being touched. They are then "laid away in layers," that is, they are put into pits of liquor of 30 to 50 degrees strength, dusting them as they are laid in. The strength of the liquor is gradually increased as they are passed from one pit to another. In each of these pits they remain about a month. The whole process of tanning occupies about 10 months, but it is said that in some yards it is performed much more speedily. Tanners who follow the old process, however, say that thorough tanning cannot be executed by this speedy method. The materials used in tanning are oak-bark, mimosa-bark, valonia, and sometimes terra Japonica, or various imported extracts, such as hemlock, chesnut, &c.; but the old tanners will not use some of these latter articles.

2. Of salted hides.

2. "*Salted Hides.*"—These are treated in the same way as "market hides," except that they are usually first soaked for a day or two before liming to get rid of the salt.

3. Of "kips."

3. "*Kips.*"—These come to the tanner in bales and as hard as a board. Before being dealt with, therefore, they must be softened. For this purpose they are put into pits of water called "soaks," where they remain until they are sufficiently softened to allow of further manipulation. Nearly all the kip tanners I have spoken with tell me that they prefer to use "old soaks;" that is to say, the same water is used without renewal over and over again for successive lots of kips. Fresh water, however, is added when necessary.

They then go to be "stocked," that is to say, the hides are beaten with heavy hammers like cloth stocks while a spray of water plays over them. I met in the course of my inquiry in Bermondsey with one kip tanner who did not "stock" his kips. The manager told me that, in consequence of this, they could not dispense with old soaks, and that they used a "shift" of four soaks of various ages, from fresh water to soaks of three weeks old. The hides had to remain in these until they were soft.

From the stocks they go to the lime pits, but, being of thinner texture than English hides, weaker lime is used. The remaining process is similar to that for market hides, only that it is not the practice to "round" them, and that they are not "dusted" or "laid away" but worked round shifts of clear liquor. They require frequent moving to ensure softness.

In many yards most of these processes are performed in the open air or under open sheds: in the best and newest yards, however, entirely under cover, or in closed buildings, as at Nickols' at Joppa, Leeds. A great deal of slopping too is unavoidable, not only in the liming and other preparatory processes, but in the tanning also. This arises out of the necessity for frequent "handling." The tan liquors are pumped, however, from one pit to another as required.

The remaining processes of drying, &c., require no notice in this Report.

Kind of tanneries chiefly complained of.

I need not refer to the position of the tanneries in Bermondsey, situated, as they are known to be, in a densely populated district. In towns I find them usually at the outskirts or in the suburbs, and, as at Leeds and Bristol, in neighbourhoods which, like Bermondsey, appear very much devoted to this trade. But in some towns I have met with them in or near the centre of the town, where, if ill conducted, they sometimes create considerable nuisance. Old tanneries, and especially "kip" tanneries, are those which are mostly complained of, when I have heard of complaints of nuisance. The newer establishments, roomy, arranged upon modern principles, and with all the modern appliances for conducting such a dirty trade in the best way, are usually no cause of nuisance at all. I met with a striking instance of this contrast at Warrington, where, about four years ago, a tannery at the end of Mersey Street, conducted by Mr. Reynolds, was a very considerable nuisance, and was very offensive to passers by. On visiting Warrington last year, missing the offensive smell, I asked the inspector of nuisances who was with me what had become of the tannery, and he showed me on the same site a new block of buildings greatly extended. The old works had been done away with, and all had been transformed.

To what extent injurious to health.

From the numerous inquiries I have made, I have been unable to ascertain that any special unhealthiness prevails in the neighbourhood of these offensive tanneries, but instances have been adduced where the offensiveness has been such as to cause loss of appetite, nausea, &c. in persons residing near them. At the same time such works, if badly conducted, may occasion about them a condition of atmospheric pollution with septic effluvia which, on the general principles enunciated in the preliminary part of this Report, must be held to be injurious to health.

Sources of effluvium nuisances.

The ordinary sources of offensive smells in connexion with tanneries are one or more of the following, viz.:

1st. The passage through public thoroughfares and reception and unloading of offensive hides, mostly, perhaps, imperfectly cured foreign hides. The office papers relating to St. Olave's, Southwark, contain the particulars of serious nuisances referable to this source.

2nd. The offensive smell proceeding from the disturbance of the old soaks in "kip" yards, when the hides are removed from them, and also when the old soaks are emptied and cleansed. The water of an old soak becomes putrid, and the deposit is horribly offensive. The cleansing of an old soak on his premises is stated to me by Mr. Nickols, of Leeds, to have produced, on one occasion, very dangerous effects upon the men engaged in the work. Dr. Parker, the late medical officer of health for Bermondsey, tells me that, in that district, the principal nuisance of tanneries arises from the old soaks.

3rd. The hauling of the hides at the lime pits is a constant source of nuisance in some yards, especially where foreign hides are dealt with. The odour emitted is very disagreeable.

4th. More or less of a similar offensive smell commonly issues also from those places where the various scraping processes are carried on.

5th. The running of the old soaks, grainers, and other offensive liquids, into drains. Dr. Davies, medical officer of health for Bristol, showed me an instance where this had been a serious source of nuisance from a kip tannery at Bedminster, the offensive smell coming up the inlets to the drain, the whole length of the street in which the tannery is situated.

6th. The general smell pervading a tannery badly arranged, imperfectly paved and drained and conducted in a slovenly manner, which smell may be carried by the wind to a distance of many yards.

7th. The destruction of the waste tan by burning.

Mode of preventing nuisances.

As to the remedies applicable to these several sources of nuisance :—

1st. It is probable that the free application to the hides, previous to their transference from one place to another, of some efficient antiseptic, such as carbolic-acid solution, would, without injuring the hides, go a long way towards lessening this nuisance. It appears from a letter from the clerk to the St. Olave's, Southwark, Board of Works (contained among the papers above referred to) that such application was effectual in abating the nuisance then complained of.

2nd. I have had several conversations with "kip" tanners upon the subject of the old soaks. I find that the duration of each soaking varies in different yards from 10 days to a month or longer in winter, and that three batches of hides is a common number to soak in succession in the same soak before the water is changed. Nearly all have also expressed to me their opinion, more or less strongly, not that the use of old soaks is indispensable (for then the water would never be changed, but only kept up by additions from time to time), but that they prepare the kips better than new soaks of fresh water do. For some time I thought this was a traditional prejudice, and I am not sure even now that the soaking in old soaks is better because better leather is made with kips so treated than with kips soaked in fresh water. None of the tanners that I spoke to said actually this. But it is allowed that the old soaks soften and prepare the kips more speedily than fresh soaks, and in most yards this is a gain which tanners would be unwilling to dispense with. When I was in Bristol, I visited the "kip" yard of Mr. Cogan, and had some conversation with him about soaks. In this yard old soaks are dispensed with, and, in place of them, the kips are put into a soak through which fresh water is continually running. Mr. Cogan says he made this alteration because he did not wish to continue a nuisance to his neighbours. He tells me from his own experience that the use of old soaks is by no means essential in "kip" tanning, as most tanners imagine. All that can be said in their favour is that they hasten the softening of the hides. He says he gets equally good results from the fresh water which he uses, but that the kips take double the ordinary time to properly soften. Besides which there is less anxiety as to injury of the hides in the soak. It is just one of those questions of trade detail which varied experience alone can solve. The difficulty lies in getting tanners so far to put aside their traditional prejudice, as fairly with open minds to make the necessary experiments. So long as old soaks are in use they should be placed as far as possible from inhabited houses. Or I might make this suggestion, that the soaking should be performed in some country place where nobody can be annoyed, and the soaked kips then be brought in covered carts to the tan yard for "stocking" and the remaining processes.

3rd. The "hauling" is a process constantly going on in a tan yard, and I can suggest no way in which it can be rendered less offensive than it is. The only way of lessening the offence to neighbours that occurs to me, is the removal of the liming pits to a part of the yard where the process may be conducted as far as possible from dwelling-houses.

4th. The same thing may be said of the offence from the various scraping processes. I find on the whole, however, that those establishments are least offensive on this and the last-mentioned ground, in which all these processes are conducted in lofty capacious close buildings ventilated from the roof.

5th. The drain nuisance at Bedminster was abated by disconnecting the tannery from the street sewer and constructing a new drain which carries the offensive liquids into the Avon, about the commencement of the ebb tide.

6th. The general offensive smell proceeding from a tan-yard may be greatly mitigated by proper drainage, paving, and general cleanliness, and by the speedy removal of all refuse matter, such as fleshings and refuse lime, from the premises. As regards old tanneries, many of the conditions giving rise to nuisance are the result of long-standing dilapidation, and the limited space within which a growing trade has had to be compressed; a condition of things which forbids much of the orderly arrangement and constructive improvements which are seen in modern tan-yards. In such cases as these, entire reconstruction on a larger area has appeared to me to be the only plan of improvement likely to be efficient. Good, firm, even paving on a prepared bottom, well and judiciously sloped to good channels, is essential in all those parts where the scraping processes are performed; and wood, so commonly used in various parts of the surface of old tan-yards, should, as far as possible, be avoided. The pits should be well built, and the edges especially constructed of a material that will not readily flake and wear away. And, above all, scrupulous cleanliness should be observed: it is quite practicable in a well paved and well drained tannery. The fleshings and the hair and lime should be swept up and removed at least once a day, and the paved surfaces swept up, no litter being allowed anywhere. Walls fouled with splashings from the beams should from time to time be scraped, and the whole interior of the buildings, where the dirtier parts of the trade are carried on, should be periodically lime-whited. Advantage is also gained by the conducting of the whole process from beginning to end in a close airy building, ventilated from the roof. I may mention as examples of well-conducted tanneries which are free from any intimation of nuisance—Reynold's in Mersey Street, Warrington (market and salted hides), Vicary Bros., in the outskirts of Bedminster (South American hides), and Nickols & Sons, Leeds (kips). In any one of these, the best modes of conducting the trade, so far as the prevention of general nuisance is concerned, may be seen in operation.

On Effluvium-Nuisances, by Dr. Ballard.

7th. The waste tan is a source of some trouble to tanners. They commonly tell me there is no sale for it, and they are compelled to get rid of it by burning; and unless this burning is effected with due precaution the smoke is a nuisance to the neighbours. A similar trouble arises sometimes in white lead works. Some tanners find they can burn it in their boiler fires, mixed with some coal, and to enable them to do this, subject it to strong pressure and convert it into blocks which they dry. Others burn it in an oven or chamber constructed for the purpose, carrying the smoke up a tall chimney shaft.

"*Pickers*" are small square blocks constructed of bullock's skin, which are used in the Lancashire looms to receive the blow of the point of the shuttle. The appear to be introduced with the object of preventing the rebound of the shuttle. "Pickers-hides" are buffalo hides specially prepared for the manufacture of these "pickers."

Preparation of "pickers" hides.

I have visited two such establishments at Broughton, Manchester. The buffalo hides come in dry like kips. They are soaked for three days or a week to soften them, fresh water being used for each lot of hides. They are then limed for about three weeks, unhaired, and if necessary a little fleshed. This is all the preparation which they receive. At one of these establishments I was informed that 200,000 to 300,000 hides are annually prepared.

One of these establishments, if not both of them, is a cause of nuisance to some neighbouring works. I myself recognised the nuisance and the character of the smell as that proceeding from either scutch or some allied material. It was very offensive. I could not visit these works on

the day I perceived the offensive smell, but I did so subsequently. My belief then was that the smell had proceeded from the lime pits, some of which were situated close to the boundary wall and leaked into the adjoining premises, partly from the refuse lime and hair scraped off under a shed close to these premises, and partly perhaps from the manipulation of the hides at the lime pits. The remedies for nuisances at such works as these must be the same, so far as they apply, as those applicable to nuisances from tanneries.

At one of these works waste pieces cut off the prepared hides are cut or sliced up into what are called "sizings," after the pieces have been dried by exposure to the air. These sizings go to paper-makers for the preparation of size. At both works the fleshings are dried for use by glue-makers.

The Manufacture of Glue and Size.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 17, 1875	Proctor and Bevington.	Bermondsey.	
„ 18 „	Young - -	Do. -	
Jan. 19, 1876	Palmer - -	Lock's Mills, Bristol.	Hair-washing. Wool-washing and drying.
„ 21 „	Turner - -	Bristol.	
Feb. 2 „	Peck - -	Warrington.	
„ „ „	Roberts, Dale, & Co.	Do. -	Manufacture of alkali and oxalic acid.
April 26 „	Hall - -	Nottingham -	Preparation of potted meat.
May 13 „	Freeman Wright -	Needham Market.	
„ 16 „	Vickers and Son -	Manchester -	Bone boiling, soap-making, manure-making, manufacture of sulphuric acid.
June 1 „	Ball and Davies -	Hunslet, Leeds -	Manure making.
„ „ „	Nickols and Son -	Joppa, Leeds -	Fellmongering and leather dressing, tanning, and extraction of fat from scutch.
„ 2 „	Clark and Thackray	Newlay, Leeds -	Leather-dressing, extraction of fat from scutch.
„ „ „	Appleyard -	Leeds.	
Nov. 21 „	Peter Brown -	Old Kent Road -	Extraction of fat from scutch.
„ 24 „	Collins - -	Bermondsey.	
„ „ „	Cripps - -	Do. -	Press fat, extraction of fat from scutch.
Dec. 4 „	Smith & Co. -	Glasgow.	
„ 8 „	Officer - -	Hull - -	Manure making.
„ 20 „	Turney - -	Stourbridge -	Extraction of fat from scutch.
Mar. 28, 1877	Poynter and Son -	Greenock - -	Manufacture of animal charcoal, artificial manure, &c.

The materials used for the preparation of glue and size are various refuse matters, from which gelatin or chondrin can by prolonged boiling be extracted in sufficient quantity to be profitable. The ma-

terials selected for the boiling vary with the quality of the article it is desired to produce, and the purpose to which that article is destined. The selection of the materials appears to be more important, in the latter point of view, in size making than in glue making. The manufacture of size for some special purposes is often conjoined with other trade processes, so that it will conduce to perspicuity to describe the manufacture of glue and of size separately. On Effluvium-Nuisances, by Dr. Ballard.

1. *Glue Making.*

1. *Gluemaking.*

Materials.

The materials which I have seen in use in glue works for the manufacture of glue are the following :—

a. "Wet" materials : Sheep-pieces or "Spetches" from fellmongers; "fleshings" from leather dressers and tanners; roundings of hides previously limed; the ears of animals; portions of bones to which tendons are attached; clippings of salted and alumed skins used for covering cricket balls, &c.

b. Dry materials : Damaged pelts (Australian); ox feet salted (Australian and South American); calves' pates (German, &c.); horn "sloughs" (the pith or core of horns); clippings and roundings of parchment; glue pieces from fellmongers, leather dressers, tanners, "pickers" hide works, and trotter boilers; rabbits' pelts and shreds from furriers.

Process.

Prior to making glue of them, all the soft tissues or materials used require to be limed. Such of them as come to glue works from the leather dressers and tanners, and some that come from the trotter boilers, as well as the dry glue pieces and parchment clippings, have been limed already. But such as have not been limed are soaked first in pits containing milk of lime. After the liming, however, the lime has to be got rid of, or "killed." With this object the limed materials are well washed with water. This washing is effected in tanks or vats, or in pits. At some works the washing is effected speedily in large barrels so arranged inside as to throw about the materials by revolution of the barrels. In the case of dry glue pieces, however, it is found sufficient to expose the material to the free action of the carbonic acid of the atmosphere, by exposing it for a prolonged period on racks in erections, covered but open at the sides, provided for the purpose. When thus prepared the materials are ready for boiling. But in some works they are subjected, after being washed, to pressure in a hydraulic press.

The boiling is effected in large open pans or boilers, of which there are usually several together. The pans are each capable of containing several tons of materials. In Young's works at Bermondsey, the charge of each pan is 12 tons of fleshings with one ton of water, the produce of which is said to be about 25 cwt. of glue. A clear space is kept at the bottom of the pan by means of a false bottom of bars. A clear space in the middle is also kept by means of a vertical framework, which can be taken out and replaced at pleasure. The object of this frame and false bottom is partly to give free space for circulation of liquid during boiling, partly to prevent burning, and partly to assist the straining off of the liquid glue. The materials are boiled either by means of a fire beneath the pan or by means of open steam, or by means of both open and close steam. In some works both means (a fire beneath the pan and steam) are provided for the same pan. The pans are usually raised upon a platform approached by a ladder or steps, and are arranged under a roof or shed open at one or on all sides. When horn "sloughs" are used it is customary to build them up around the outside of the central

framework, before putting in the other materials. During the boiling, a man is employed in stirring up the contents of the pan from time to time and in skimming off the fat which rises to the surface.

When the boiling is completed, the fire is raked out, sufficient time is given for settling and partial cooling, and then the liquid glue is drawn out from the space beneath the false bottom along a wooden channel, in which lumps of alum are laid, to wooden troughs ("coolers") on the ground and about a foot wide and deep, in which the liquid is left to solidify into a very firm jelly or size.

During the solidification, froth and some fatty matters rise to the surface, and in some works these are skimmed off; in other works they are left to solidify with the glue, and are dealt with in the next process.

This process consists in cutting the contents of the troughs into slices. The solidified material is taken in blocks from the troughs, and by an arrangement which it is unnecessary to describe are cut upon a bench into slices by women. When there is any scum on the surface of the blocks, it is first cut off and put aside to be returned to the pans.

The slices thus cut off are carried to sheds or erections open on all sides to the air, and are there laid upon nettings to dry spontaneously. When perfectly dry and hard, any mouldiness upon them is scrubbed off with a brush and warm water by women, after which they are laid on a rack to drain and dry, and are finally removed to a chamber heated artificially to between 85° and 120° for a final drying.

The matter left in the pans after boiling is termed "scutch." It is commonly thrown out of the pans in a heap upon the ground, sometimes under the shed where the pans stand, and sometimes in the open air, where it remains until removed to the manure makers. Sometimes it is sent to the manure makers in the condition in which it leaves the pan; at other works it is previously deprived of fat, and at others it is made into manure on the premises without any previous removal of the fat it may contain. The "sloughs," when taken from the pan, are set aside in a separate heap for the use of bone-manure makers.

2. *Size making.*

2. *Size Making.*

Size of very different qualities is make at glue works. Some destined for rough work is made of similar materials to ordinary glue, while other varieties of a fine quality, destined for the manufacture of gelatin and for use in soups, are made with especial care and precautions, and

Process.

of very carefully selected pieces, such as "calves' pates." So far as I have been able to gather, it is important that, after liming, the lime should be more completely removed than is necessary for glue making, and for this purpose the pieces are first treated with a weak solution of hydrochloric acid. The boiling is effected in a similar manner to that of glue, except that I have observed that free steam is more frequently used for heating the contents of the pans than in glue making. The liquid size is either run out into little tubs for sale, or into a large vat, out of which it is taken and broken up for packing in tubs. The finest kinds of size for esculent purposes are made into blocks. I have seen steam-jacketed pans used in making the finest kinds of size. Some of the fine kinds of size made at ordinary glue works go to the paper makers.

In some works size is made by first acting upon horn piths with hydrochloric acid and then boiling them with water. I shall defer what I have to say about other modes of manufacturing size until I come to the subject of "bone-boiling."

Glue works are often a cause of very considerable nuisance to the neighbourhoods in which they are situated. Dr. Davies, the Medical Officer of Health for Bristol, told me that the offensive effluvia from some works I visited near Bedminster created a nuisance at a distance of 400 yards from the works. About five years ago, the proprietor of these works was prosecuted in consequence of a serious pollution of the Malagold stream, which ran through the works, and at that time received all the liquid refuse and sewage from them. There was in the stream a deposit of the depth of three feet, and the stream as it ran through the borough was rendered very offensive. At the time of my visit to Leeds proceedings had also been commenced by the local authority in respect of a serious nuisance from glue works at Hunslet.

On Effluvium-Nuisances, by Dr. Ballard.

Nuisances.

The most obvious kind of injury to health arising out of the effluvium-nuisances proceeding from glue works is that which must be referred to the impression upon the senses made by the offensive effluvia. But on the general principles stated in the early part of this report, the septic atmosphere engendered about ill-managed glue works, and arising out of the decomposition of animal matters in and about the yard, must be held also to be damaging to the health of persons residing in the neighbourhood who may be much exposed to its influence. Probably a high rate of mortality in the population immediately exposed to the effluvia arising from the Hunslet works just mentioned has been in part due to this cause. Dr. Goldie, the Medical Officer of Health for Leeds, in whose district the works are situated, is decidedly of opinion that such is the case. He tells me that during six years ending December 1875, in an estimated population of 1,935 persons, not exceptionally poor or overcrowded, and situated in a comparatively open part of the borough, the mean annual mortality from all causes amounted to 35·66 per 1,000, while that from the five zymotic diseases, small-pox, scarlatina, measles, "fever," and diarrhœa, amounted to 9·12 per 1,000. Taking the whole of the Hunslet ward in which this little colony is situated, the annual death-rate from all causes during the same six years varied from 27·0 to 29·9, the mean being 27·9; and the death-rate from the five zymotic diseases mentioned varied from 4·6 to 6·0, the mean being 5·4. The annual mortality of the whole borough during the same six years varied between 26·4 and 28·5 per 1,000, and that from the five zymotic diseases mentioned varied from 3·6 to 5·9 per 1,000. Dr. Goldie tells me from his knowledge of the district that he is not aware of any conditions of locality or character of population that could possibly account for the great mortality about the glue works, other that the presence of the offensive works themselves.

Injury to health.

The sources of nuisance from glue works may be any of the following:—

Sources of effluvium nuisance.

1st. The deposit, accumulation, or too long detention of moist "fleshings," or other decomposable material in the yard. At the Hunslet yard above mentioned I found a large heap of several tons of fleshings which had become absolutely putrid and were only fit for manure making. The proprietor told me in extenuation, that he had unfortunately overbought himself; such an occurrence may be sometimes unavoidable, especially in small works were pans are not kept in reserve for dealing with such emergencies as irregularities in the delivery of materials, &c.; but the fact of this having led to nuisance disposes at once of an argument sometimes used by manufacturers of various kinds, that it is against their interest to incur waste.

2nd. The effluvia of the steam issuing from the boiling pans.—Where the best selected materials are in use this is tolerable, unless when the

effluvia enter in large quantities the windows of adjoining houses. But the offensiveness of the effluvia is greater when the rougher materials are used, and intolerable if they have undergone any amount of decomposition, as for instance in consequence of having been retained too long before being used. I am speaking now of an amount of slight or superficial decomposition, not sufficient to render the material valueless to a glue maker, and such as is apt to occur in any works in hot weather. It is said that "sloughs" give a bad odour to the effluvia and to the glue.

3rd. The deposit and accumulation of "scutch" upon the premises. This is perhaps the most common of the more serious nuisances arising from glue works. In some works I have seen accumulations amounting, I should think, to 100 tons or more, which must have been many months in formation. The odour of an old accumulation of decomposing "scutch" is ferocious and sickening, and travels to long distances with the wind.

4th. The general effluvia proceeding from untidy works which are unpaved or undrained, or imperfectly paved and drained, and where scraps of fleshings and other soft materials are strewn carelessly about the ground, and left there to putrify; or where scraps and loose pieces of gelatinous glue are allowed to fall upon the ground and become trodden down. Again, all this is waste; it is contrary to the interests of the manufacturers, but nevertheless it is a state of things which was to be seen in the majority of the glue works that I visited.

It may occasionally happen that a nuisance proceeding from glue works may depend, in part at least, upon the manufacture of scutch-manure upon the same premises.

It is not at all necessary that glue works should be a nuisance to the neighbourhoods in which they are situated.

Modes of preventing nuisances.

1st. As respects the materials brought into the works.—The moist materials, if not to be used immediately, should be at once placed in weak or old lime pits or tanks, and in the event of an unexpected receipt of limed fleshings or pieces beyond the manufacturer's requirements for some length of time, it would be better (if the weather permits) to dry them off for future use than to leave them in loose heaps in the yard, especially in an open yard, and not under cover. At Turney's, in Stourbridge, whose establishment I visited in the month of December, when very little work was going on, I found moist fleshings being carefully stacked for future use. Mr. Turney informs me that before stacking the pieces in the winter they are washed through a milk of lime in a washing machine. They are then stacked (about 100 tons in a heap) as closely as possible, so as to exclude the air. The stacking requires care. If any hollow places are left, the pieces become bad very soon. They are best put in large heaps 6 or 8 feet high, since their own weight presses them down, and in a few days the heap becomes quite solid. If at any time the sides or top of the heap become tainted, a layer of about 6 inches has to be cut off and re-limed. He says that he should, if requisite, follow the same practice in summer as in winter. He considers that the practice adopted by some manufacturers of preserving their fleshings immersed in lime liquor in sunken pits is more injurious. An excess of lime has to be guarded against, since it destroys, he says, both the glue and the grease. The pieces which have been in lime for a long time yield much less than those boiled while fresh. Properly stacked pieces may without injury be preserved throughout the winter, or even for twelve months. Mr. W. A. Bevington, of Bermondsey, another very large manufacturer, agrees with Mr. Turney. He writes to me that "in the event of a glue manufacturer being from

" any cause overstocked with 'wet' goods, and being unable to use " them fast enough, the best method is, broadly, to dry them; but this " course is often impracticable for several reasons, such as, *a*, because, " if the weather be bad for glue, it is at the same time bad for drying " fleshings; *b*. because of the want of proper appliances and space; " and *c*, because it depreciates the value of the goods, as when once dried " they cannot be used for the same purposes as wet goods, *e.g.*, for size- " making. The method of drying being put out of the question, the " next best thing is to stack them; and if this be done properly, they " are but very little injured by keeping for several months and are no " nuisance whatever. The way to do this is to place on a well-drained " spot a layer of the fleshings a few inches thick, the size of the pro- " posed stack, and then to throw over it a liberal supply of milk of lime, " then put on another layer of fleshings, and treat it in the same way " with milk of lime, and so on until all the goods are stacked. This is " what we do ourselves, and we have at this moment about 200 or 250 " tons so preserved." All this would appear to be to the interest of the manufacturer, and would certainly conduce to the comfort of his neighbours.

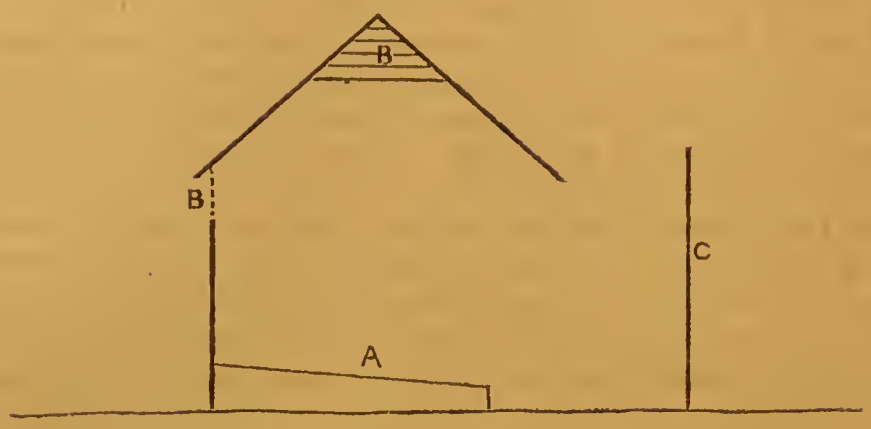
2nd. I have heard no good reason assigned for the universal practice of permitting the vapours from the boiling pans to diffuse into the atmosphere outside the sheds. There can be no more reason why this should be, than that it should be permitted to occur in the works of soap boilers, trotter boilers, &c., where, as I shall show, methods of preventing the escape of offensive vapours from the works are in use at some establishments. Two methods of dealing with them may be suggested. One is the partial closure of the sheds in which the pans are situated, with the use of a fan to draw off the vapours from the interior of the building to a tall chimney shaft; and the other is the covering of the pan with a cover provided with such a hinged lid as shall permit of the workman stirring the contents and skimming off the fat; conjoined with a flue carrying the vapours into a fire so arranged as to produce a down draught into the pan. In a conversation I had with Mr. Bevington, jun., of Bermondsey, he said he saw at that moment no difficulty in this, and that if he had to reconstruct, he should probably introduce some such arrangement. I have observed during my visits to glue works that the vapour from the pans has been least offensive when they have been heated by steam, either by jacketing the pans, or by the use of open steam.

3rd. The accumulation of "scutch" in heaps in the glue yard, and its retention there, is an instance of traditional trade slovenliness which ought at once to be put a stop to. There can be no excuse whatever for the continuance of this source of nuisance at any of the works I have seen. The "scutch" ought either to be put at once into hogsheads, and fastened down for removal; or, until it is removed in covered carts or barges, or in hogsheads, it should be deposited neatly in an appropriate chamber or shed, and not be allowed to be retained even there above a day or two, especially in warm or muggy weather. This is the plan adopted in Mr. Freeman Wright's works, one of the best conducted glue works I have visited.

Mr. Wright tells me that a well-ventilated shed, open on one side and provided with a raised platform on which the scutch may be laid, and a screen to hide it from view, is better than a closed-in shed or chamber. The roof and walls of such a shed, however, should be whitened outside for coolness in the summer time, and be kept scrupulously clean and

limewhited inside. The following is a rough plan of a proper scutch shed :—

Fig. 3.



A. Raised platform. B. Louvres. C. Screen.

At Nickols, Joppa, Leeds, and at Clark and Thackray's, Newlay, Leeds, the "scutch" is dealt with, immediately on its removal from the pans, for the extraction of the fat it contains, and the conversion of the "seutch" into a cake which is almost devoid of odour. And I should think that while preventing annoyance to neighbours, the proprietors find the proeess profitable. On its removal from the pans the "scutch" is thrown into a tank of water, and some sulphuric acid being added, free steam is thrown in. The fat which rises is taken off, and the residue is put into coarse bags and subjected to pressure in a well-closed hydraulic press, into which more steam is thrown. The liquid matters pressed out run into a tank, where more fat rises and is collected. The cake is stored on the premises without giving offence until it is convenient to have it removed. But in some other works I have visited where the same process is used, I have seen the cake laid in a heap and exposed to the weather in the open yard ferment and become offensive. Such dry cake should be stored under cover. Messrs. Turney, of Stourbridge, have an arrangement of a different character for separating fat from scutch before its removal from the premises. It will be described when the subject of scutch manure making comes under consideration.

4th. The general untidiness and superficial filthiness of glue yards is only another instance of slovenliness showing the conservative power which attaches to ancient tradition. It need not be so, and in the interest of the manufacturer would be better not so. All parts of the premises should be firmly and evenly paved with appropriate materials and duly sloped to good channelling, and well drained throughout. No litter of any kind is necessary, or should be permitted. The surface should be kept constantly swept up, and washed down with water from time to time. Every scrap of gelatinous glue should be gathered into proper receptacles for return to the pans. Leakages from channels and troughs should be immediately made good. The interior and edges of the pans, and everything about them, should be kept clean and free from deposits, and tidiness of working be maintained, as it readily may be, by due regulations for the establishment.

The remedies for nuisances arising out of the manufacture of scutch manure, will be treated of under the heading of artificial manure making.

Description of two establishments.

I cannot conclude this part of my Report more usefully than by giving the description I find upon my notes of two glue-making works; the one about the worst conducted that I have visited, and the other beyond all comparison the best conducted.

1. Works at Hunslet, Leeds.—The area of the entire premises is about 2 acres. The total annual production of glue is stated to be about 150 tons, and 50 hands on an average are employed. The surface on which the works are erected slopes back from the road. It is only partially paved, and in the parts which are paved the paving is most defective and very irregular, so that pools of offensive liquids are to be seen in various parts of the surface of the yard. Heaps of fleshings, "seuteh," &c. are deposited in all parts of the open yard, and in one place was a large heap of putrid fleshings, only fit for manure. The boiling pans are steam heated, but are very filthy, with "scutch" lying about them, in the shed and outside the shed, and dried upon the edges of the pans. At the rear of the works, where the cooling troughs are, the ground is saturated with spilt glue and filth, and there are large heaps of refuse accumulated, part of which was being manufactured by hand labour into a kind of manure.

2. *Freeman Wright's* works, Needham Market, Suffolk. — These works are in two parts, situated on either side of a lane and railway. On the one side all the wet parts of the process are conducted, and on the other side all the dry parts. About 50 tons of glue are produced annually, and 25 hands on an average are employed. The materials used are the usual "spetches" "fleshings," small dry clippings of skins and hides, rabbits' pelts and shreds, and trotters. The moist limed materials not immediately required for use are put into tanks containing a weak solution of lime, and each tank is, as well as the washing tanks, ticketed with the dates of reception of the material, the dates when it ought to be removed, and other particulars of its contents. There are (in consequence of the lowness of the ground) but few pits here, and the washing and clarification of the "pieces" (equally with the preservation of them), performed in other works in pits, are performed in raised tanks instead. Mr. Wright finds this arrangement convenient and conducive to cleanliness. The pans are clean, and heated by open fires. "Seuteh" is not allowed to accumulate. It is chiefly at once put into bags or into casks, which are immediately covered down and then sent away by rail. At the time of my visit there were only one or two casks on the premises in consequence of a delay in their return, and the "seuteh" in small quantity was lying tidily in two small heaps upon a platform beneath a shed in the yard. It was not offensive. When Mr. Wright is from circumstances compelled to retain it for a time, he covers it with a carbolic powder. What struck me most forcibly at these works were the perfect cleanliness, tidiness, and order which prevailed in all parts, even in those parts where the wet parts of the process were being conducted. There was no dirt or litter of any kind about the works; all was well swept up. The surface was everywhere well paved with the best bricks made in the county (Woolpit bricks), which are hard and do not readily flake. The pavement is laid upon a bottom of chalk, and is properly sloped, channelled, and drained. On the side where the glue is dried, and the further final processes conducted, equal cleanliness and tidiness prevailed. In the drying sheds even, all dirt had been removed from the stairs and platform, and the sorting rooms and warehouses were swept clean. In short, there was as much difference between these works and the ordinary run of glue works, as there is between the stables and stable-yard of a nobleman's mansion and a London cab yard and stables. And all this was not the result of a special preparation for my visit, for I only arrived in Ipswich on one evening, and visited these works early the next morning. Besides, Mr. Elliston, the Medical Officer of Health for the district, told me that whenever he has visited them he has always found them in a similar condition. Mr. Wright has kindly permitted photographs of his

On Effluvium-Nuisances, by Dr. Ballard.

works to be taken for the purposes of this Report, with the object of showing in how tidy and cleanly a manner it is possible to conduct processes which are too commonly performed in an uncleanly and slovenly manner. They show correctly the condition of the premises at the time of my visit.

THE MANUFACTURE OF PRUSSIATE OF POTASH.

THE MANUFACTURE OF PRUSSIATE OF POTASH.

Establishments visited.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
June 1, 1876-	— Foster - -	Leeds - -	Removing grease from currier's scraps.
„ „ „ -	Samuel Foster -	Do.	
„ 14 „ -	McKenny -	Clayton, Manchester.	
„ „ „ -	Sir E. Buckley -	Do. do.	

Process.

Prussiate of potash is made by heating together crude carbonate of potash, and various kinds of refuse animal matters, such as "flocks" (the waste or refuse woollen dust from wool mills), clippings of leather, horn, hoof, &c. The proeess, where I have seen it, is conducted in a closed building with louvre openings in or along the roof. Iron pots about 2 to 3 feet wide and deep are used, and are arranged in a bank and heated by fires underneath them. There are always more pots than are in use at any one time, since they wear out after a few weeks' use, the material of the pot furnishing the iron necessary for the formation of the salt. Eaeh pot is furnished with a flat iron cover, capable of partial removal for introduction of material, and also with a stirrer inside, the vertical shaft of which passes through the cover, and which is set in motion by a mechanical arrangement passing along horizontally above the whole series of pots. The potash being put in, the animal material is added in shovelfulls from time to time, the removable portion of the cover being raised for the purpose; the heating operation is continued for three or four hours, and then the contents of the pot are taken out and thrown into a tank of cold water, which dissolves out the prussiate. A carbonaeeous matter remains after solution, and is usually sent away to sewage or manure works to be used as a deodoriser. The further proeesses are wet processes, and consist only in recrystallization of the salt upon strings suspended in the crystallizing tank.

Effluvium nuisance.

During the heating process flame and offensive smoke issue from the gaps about the covers of the pots, and directly from the pots themselves when from time to time it becomes necessary to raise the cover to put in fresh material. This smoke fills the house, and, issuing from it, is often a source of nuisance to neighbours. I am not, however, aware of any other injury to health that it occasions beyond such as may arise from the impression made upon the senses. I am informed, however, that such works as these have created nuisance perceptible at a distance of 100 yards from the works.

Mode of preventing nuisances.

The best mode of preventing nuisance which I have seen in operation was Buckley's works, at Edge Lane, Clayton, near Manchester. The arrangements here, which have been most effectual in obviating a nuisance previously much complained of, were devised by Professor Roscoe, of Owens College, Manchester. They are represented in Plate 5. From the baek part of the lid of eaeh pot a pipe passes first upwards

then horizontally, and lastly, vertically downwards to the back part of the flue which surrounds and heats the pot. The pipe is hinged at the junction of the short horizontal and the descending part, to allow of the lid with the part of the pipe connected with it being raised. The result is that the smoke and fumes instead of escaping into the building are drawn down to the flue where they meet the flame of the fire and are consumed, the products of the combustion being carried off by a tall chimney shaft. The building, in which 21 pots are arranged along one side, is very capacious, being about 50 yards long by 11 yards wide and 11 yards high. It is lighted all along the top of the roof by skylights, below which are louvres. It it also ventilated by openings in the side and end walls. Eight pots were working when I made my visit, and there was no offensive smoke or odour perceptible either in the works or outside them.

The Boiling of Flesh, Tripe, Trotters, Ox Feet, &c., and the Preparation of "Neat's Foot Oil," and the Trade (sometimes associated) of preparing Glue Pieces.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875	Harrison - -	Belle Isle - -	Knackery.
„ 19 „	Briar - -	South Bermondsey	Preparation of glue pieces, manure making.
Dec. 11 „	Shaw - -	St. George's, Southwark.	Knackery.
Jan. 19, 1876	Neat & Co. -	Bristol.	
„ 21 „	Kent - -	Do. - -	Do.
April 26 „	Hall - -	Nottingham	Size making, bone boiling.
May 17 „	Eardley - -	Manchester.	
„ „ „	Lane - -	Do.	
June 1 „	Watson & Co. -	Leeds - -	Fat melting, soap-making, &c.
„ „ „	Hargreaves -	Do. - -	Fat melting, bone boiling.
„ „ „	Harland - -	Do.	
„ 15 „	Saycell - -	Salford.	
Oct. 26 „	Cattle Market -	Deptford - -	Slaughtering, &c.
Nov. 24 „	Cordrey - -	Bermondsey.	
Dec. 2 „	Abattoir - -	Moore Street, Glasgow.	Do.
„ 4 „	Hodgkinson -	Glasgow -	Knackery.
„ „ „	Glen Park Knackery	Do. - -	Do.
„ 8 „	Nicholson -	Little Driffield -	Leather dressing, manure making, &c.
„ „ „	Barron - -	Sculcoats, Hull -	Bone boiling, fat melting, manure making.
Jan. 10, 1877	?	Near Portsmouth -	Knackery.
„ 19 „	Stronach - -	Belle Isle - -	Do.
Feb. 13 „	Adams - -	Birmingham -	Do.
Mar. 15 „	Walton - -	Near Cambridge -	Knackery, piggery, manufacture of artificial manure.
„ 27 „	Arthur - -	Greenock.	
Various times	Various piggeries.	—	

On Effluvium-Nuisances, by Dr. Ballard.

I have thought it best not to disconnect these trades, first, because, although often carried on separately, they are sometimes variously combined; and secondly, because the means of preventing nuisance from the several kinds of boiling are alike in all. On other grounds also it will be convenient to consider them together.

Places where the trade is carried on.

The boiling of flesh (horseflesh, and sometimes diseased meat, or the flesh of cattle which have died without slaughter), is always carried on in knackeries, the boiled flesh being sold for dogs' and cats' food, while the fat is skimmed off and sold for use by soap-boilers and others. The boiling of inedible offal is also generally carried on at places where pigs are kept. Tripe, trotter, and ox feet boiling are usually conjoined as one trade with the preparation of neat's foot oil, but sometimes the boiling of tripe is excluded. Trotter and ox feet boiling is sometimes, as at Briar's establishment in South Bermondsey, conjoined with the preparation of "glue pieces," *i.e.*, portions of skin which, after preparation, pass on to the glue-maker for the manufacture of glue or size. Sometimes the trade of tripe boiling is associated, as at Watson & Co.'s at Leeds, with that of soap boiling; but usually it is carried on in conjunction with the boiling of trotters and ox feet in comparatively small establishments, sometimes in the cellars or kitchens of dwellings, and by poor people who make a small living out of the sale of these articles as food when boiled. In all cases the fat which rises in the boiling is skimmed off and preserved.

Process at knackeries.

At knackeries the flesh is boiled in large boiling pans usually situated in the slaughtering shed or building; they are set in brickwork and heated by a fire beneath, but occasionally, as at Stronach's, Brandon Road, Belle Isle, and at Kent's, near Bristol, by free steam thrown in. The fat is skimmed off and set aside in tubs for use by soap boilers. When the flesh is sufficiently cooked it is taken out and placed on the floor of the slaughter-house (sometimes on hurdles upon the floor) to cool, and it is then hung upon hooks until it is removed. The liquor or broth is ladled out hot and thrown into a channel in the floor, which conveys it away to a drain inlet or otherwise, as the case may be. In some establishments the stomachs and intestines are similarly boiled, being previously partially emptied of their contents, and with them sometimes the second, third, and fourth stomachs of sheep and oxen slaughtered at the ordinary slaughter-houses and sent from them for preparation as dogs' food.

Process of tripe dressing and boiling.

Tripe, which is the first stomach of the ox or sheep, undergoes some preparation before being boiled for human food. The contents of the stomach having been emptied out (which is usually done at the slaughter-house), the tripe is washed and scalded, and the interior villous membrane is then scraped off. This operation of scraping is usually performed by women, or sometimes by men, at a table on which the tripe is laid, and by hand with an appropriate scraper. At Watson & Co.'s in Leeds this operation is effected by means of a cylindrical-shaped brush with stiff bristles, revolving in a trough through which water constantly runs from a tap above. The workman cleans the tripe by pressing the surface against the brush as it revolves. The tripe is then boiled, usually in an iron pan set in brickwork and heated by a fire beneath. The fat is skimmed off and set aside for use by soap-boilers. At Watson & Co.'s the boiling is effected in steam-jacketed pans. When the tripe is sufficiently cooked it is set aside or hung up to cool, and the liquor is run off and discharged into the drains. When trotter and ox-feet boiling are conjoined, the boiling arrangements are similar, and the preparation for boiling is similar to that which I am now about to describe.

Process of trotter and ox-feet.

In describing the trade of trotter and ox-feet boiling, and the preparation of neat's foot oil, I cannot do better than state what I observed

as the mode of carrying on the business at an establishment in South Bermondsey, not only the largest of the kind in London, but the largest I have seen anywhere.

Description of an establishment at Bermondsey.

The materials received at this establishment are, 1, Ox-feet, cut off about 18 inches above the hoof; 2. Horses' feet (deprived of the shoes), cut off at about the same length; 3. Sheep's feet cut off about 3 inches above the hoof, and having attached to them a strip of skin with the wool on, about 8 or 10 inches in length. This last material comes from the fellmonger. The ox and sheep's feet are first sorted, the best and freshest are prepared for human food, and the rest are set aside in a heap to be used otherwise. The work to be described is performed in a variety of sheds, some more or less closed and some open. I will describe the dealing with the several materials separately.

Mode of dealing with ox feet.

1. Ox feet.—*If not intended for human food*, the skin is first stripped off them by a woman who sits on a low seat by the side of a heap of them. She then slits them longitudinally with a knife, which she passes between the divisions of the hoof and carries up between the two long bones of the foot. Near the hoof is a small mass of soft fat, which she scoops out with the knife and sets aside for the preparation of the best kind of "neat's foot oil." The hoof is then cut off at a joint, and the skin, hoofs, and fat are then dealt with separately. The place where this work is done is an open unpaved shed, the whole space under the roof of which is lined with pieces of limed skin in process of drying for "glue pieces." Many women at one time are employed in this shed in the process described. *a*. The pieces of skin are first thrown into a brick tank sunk about 3 feet deep in the earth, and are then soaked for about a day and a half in a weak solution of lime. They are then transferred to a second similar tank containing a stronger milk of lime, where they remain about three days, and from this to a third similar tank of strong lime and water, where they remain until wanted, a few days or six months, according to the demand for them. In the course of this liming process, the skins pass through the hands of some women who sit and scrape the hair off them. When the skins are finally taken from the pits they are laid in a heap on the ground close by to drain; and the drainings from them run over the ground to a surface drain covered with planks, which is considered a convenient arrangement as facilitating the cleansing of the drain from lime-grounds. The limed and scraped skins are either dried for glue pieces by suspending them in open sheds, or are sent away undried, it is said, to paper makers for the preparation of size. The hair is disposed of for manure-making. The smell proceeding from the pits, when disturbed to remove the skins and the lime from them, was intolerably disgusting and ammoniacal. When the skins have been finally removed, the pits are cleaned out, and the lime and hair are laid in a heap upon the ground until removed into an adjoining yard. *b*. The hoofs are washed with cold water and then boiled in open pans set in brickwork and heated by a fire beneath. Oil is thus boiled out of them, and when skimmed off forms an inferior kind of "neat's foot oil." After sufficient boiling (about three hours) the tissues between the horny hoof and the last digit bone are softened enough to allow of the latter being easily scooped out of the hoof with a knife. The horny hoofs are then thrown on one side in a heap, and are sent away for the manufacture of buttons, combs, &c. The "cores," consisting of bone, gelatinous matter, and fat, together with the small pieces of fat, removed in the first operation, are then put into a separate pan of fresh water, where they are all boiled together for the extraction of oil, which then forms the best kind of "neat's foot oil." When all the fat has been extracted and skimmed

Glue pieces.

Neat's foot oil.

On Effluvium-Nuisances, by Dr. Ballard.

off, the bones are removed and set aside for the manure maker, and the liquor, which is highly gelatinous, is said to be run off into the drains. Some, spilt about on the ground, had there gelatinised at the time of my visit. Some, it was said, is mixed with other waste materials on the premises for the manufacture of a manure. *c.* The shanks or long bones of the foot are similarly boiled in open pans, and are then thrown into cold water, sorted when dry, and sold for making knife handles. If *intended for food* the ox feet are not split, but are boiled in separate boilers for the preparation of "cow-heels;" otherwise the process is similar to that above described.

Mode of dealing with sheep's trotters.

2. Sheep's trotters.—*If not intended for food*, which is when they have undergone such an amount of decomposition as would unfit them for such use, they undergo three limings; the first liming is little else than soaking in water, in which they decompose somewhat. A most offensive putrid smell arose when the contents of this tank were disturbed and when the trotters were taken out. The skin is then removed, freed from wool, and dried for "glue pieces." They are then thrown as they are into boiling pans where the fat is boiled out; and the residue, bone, skin, and hair, is turned out in a heap upon the ground. The mass is then sorted, the longer bones are put in one place for purchase by manufacturers of bone articles, the smaller bones are set aside for the purposes of the manure manufacturer, and the remaining soft matters are thrown upon the heap of lime refuse, &c., outside the works. The fat skimmed off is often very offensive; it is put into casks and sold, it is said, to soap boilers. *If intended for food* the trotters are first scalded in a boiler, and, when they are taken out, boys are set to get the hoofs off. They are then taken into an open unpaved shed furnished all round with bins, at which women sit, who with a knife cut off the loose skin, and scrape the hair from the edible portion. They are then ready for boiling.

Manure making.

At these works manure is also made from a mixture of lime-grounds, wool, hair, and cotton waste, to which the gelatinous liquor from the pans is added, and all is turned over from time to time with a fork. The mixture heats and emits an offensive ammoniacal odour. Sometimes sulphuric acid is added.

Effluvium nuisances.

The businesses which I have been describing are often a source of nuisance from the offensive effluvia proceeding from them. But they are not all alike in this respect, since they vary with the character of the matter boiled and the pains taken to avoid producing nuisance. When the matters dealt with are putrid or semi-putrid, the nuisance is necessarily very much greater than when fresh substances are boiled for human food. But even in the latter case tripe and trotter boiling houses are apt to be a source of nuisance to close neighbours; and in many places that I have visited health officers have been requested to advise as to the mode of obviating the nuisance they have occasioned. The offensive odour from the more offensive establishments has produced in some persons the ordinary disturbances of health ordinarily produced by offensive effluvia which make a strong impression on the senses; but I have had no satisfactory evidence given me of injury to health of a deeper kind. Still, on general principles, such businesses as that last described, in the conducting of which putrid emanations are largely given off, cannot fail to injure health, if they are established in close populous neighbourhoods.

Sources of nuisance.

The sources of nuisance from this class of establishments are:—

1st. The vapours issuing from the boiling pans. They are always more or less disagreeable, and especially so if they enter the doors and windows of neighbouring houses; but more particularly are they

offensive and even disgusting when semi-putrid matters are boiled, as may happen at a knackery, which, especially in the summer-time or in close muggy weather, receives dead horses from a distance, or has insufficient means of disposing of an unusual number of carcases brought upon the premises at one time, or as invariably happens daily in such establishments as that last described.

2nd. The vapours issuing from the boiled materials laid aside to cool.

3rd. The vapours issuing from the liquor from the pans when it is ladled out and allowed to run along open channels to a drain gully.

4th. The general offensive odour proceeding from an untidy, filthy, and badly kept establishment where animal matters are dropped and spilt about the floor, and defile the premises generally with the odour from their decomposition, or where accumulations of decomposing refuse matters are kept upon the premises.

5th. The offensive odour proceeding from the lime pits, especially when disturbed, and when their contents are taken out.

6th. The exposure of wet glue pieces to dry in the open air or under an open shed.

7th. The effluvia proceeding from associated trades such as the manufacture of manure from the refuse of the works.

As regards the remedies applicable to these several sources of nuisance:—

Modes of preventing nuisances.

1st. In small tripe and trotter boiling establishments it may suffice to conduct the boiling operations beneath a hopper brought down sufficiently low and closed in at the sides of the boiler, and to conduct the steam, issuing at times when the boiler is open for the removal of any of its contents, into a chimney with a good draught and discharging itself at an elevation above the level of adjoining houses. But the boiler itself should be provided with a lid, and there should be a pipe to convey the steam from the space immediately under the lid into the ashpit of the fire, which ashpit should be provided with a well-fitting door. The arrangement is one which I shall have to mention again in connexion with some other trades, as bone boiling and fat melting. (See Fig. 4, p. 95.) At Watson & Co.'s in Leeds, the vapours from the covered boiling pans are drawn off by a fan (as they are also from other boiling and fat melting pans on the premises) and driven through a furnace fire: this is very effectual. At Stronach's knackery at Belle Isle the vapours from the boiler (closed and heated by free steam) are conducted into the fire of the boiler which furnishes the steam. This also is effectual in obviating nuisance.

But one of the best arrangements for large establishments that I have seen is in use at Adams' knackery in Lord Street, Birmingham. It is an arrangement for catching and condensing the vapours, and was put up under the direction of Dr. Alfred Hill, the Medical Officer of Health for the borough: it has proved most efficient. Plate 6 is the plan of the arrangement. At this establishment there is along all one side of the slaughter-house a row of six boiling pans set in the usual way, and each heated by a fire beneath. They are enclosed above in a sort of closet, formed by a wooden partition reaching to the roof of the building above, and below extending down to the front part of the top of the boilers. Opposite each boiling pan there is in the partition a shutter which slides upwards, and which can be raised whenever it is requisite to obtain access to the boiling pan. Each pan is, moreover, closely covered down with a wooden cover, and from the upper and back part of each pan, beneath the cover, a pipe leads to a 10-inch main pipe which runs the whole length above the pans and within the hopper, and receives contributions of vapour from each pan. This

pipe finally makes an exit at the exterior of the building, and here communicates with an oblong condenser made of sheet iron and filled with coke. The condenser, which measures about 14 feet long, 3 feet from above downwards, and about 14 in. from side to side, is inclined a little in its long diameter; at the lower end it receives the pipe from the boilers, and from its lower border another small pipe conveys away the water produced by the condensation of the vapour; the cooling agent is the outside atmosphere to which the condenser is exposed on all sides. The upper end of the condenser communicates by two air pipes with the flues from the fire places. When the boiler lids are raised, the vapour that issues rises towards the roof, and is conveyed from the interior of the closet into the chimney shaft by escape steam pipes provided for the purpose.

2nd. At knackeries the second source of nuisance may be obviated by throwing the boiled meat directly from the boilers into a tank of cold water, or (better still) through which cold water is constantly flowing. After a few minutes the surface is sufficiently cooled to give off no more vapour. At one time this arrangement was adopted at one of the knackeries at Belle Isle, but its use has been abandoned. It would scarcely be requisite to adopt any similar plan of procedure at a tripe and trotter establishment, since the matters boiled are less apt to be offensive, are small in bulk, and cool much more speedily than lumps of horseflesh, beside which I do not know how far it would affect the appearance of the cooked food.

3rd. The obvious remedy for the third source of nuisance is to permit the liquor to cool in the pans before discharging it, and to discharge it into the drain through a covered channel of some kind.

4th. The remedy for the fourth source of nuisance is to be found in due structural arrangements, scrupulous cleanliness, and the daily proper removal of refuse matters from the premises. The buildings in which all the dirty parts of the business are conducted should be airy and well-lighted. The floor should be evenly paved, preferably with cement or some other jointless paving, and duly sloped to properly constructed gullies leading to well-laid pipe drains. The walls should be covered with a smooth layer of cement or other material capable of being washed, to such a height from the floor as shall include all parts likely to be defiled by splashings, &c., and the remainder should be limewhited periodically. No litter should be allowed, but proper impervious vessels should be provided to contain any materials which may be undergoing any process of manipulation, and the benches and tables should be even, and capable thus of effectual cleansing. And after the close of each day's operations, the floor, lower parts of the walls, and all utensils that have been in use, should be thoroughly washed and cleansed. All refuse should be at once placed in impervious moveable receptacles fitted with covers, and should be daily removed from the premises in these receptacles to some place where they cannot be a nuisance.

5th. It is difficult to say what should be done to avoid nuisance from the lime pits in which bits of putrid skin and trotters are put to soak. The offence from these is much greater than from the lime pits in fellmonger's yards, since in this latter case the matters soaked in them are not absolutely putrid. It appears to me, however, that this soaking operation and all the manipulations connected with it ought to be performed in a closed building ventilated at the roof, and not in the open air or in open sheds. Should this not be sufficient to protect neighbours from the offensive smell, the air might be drawn out of the building by some mechanical means, and conducted through a fire or a sufficiently capacious cylinder or chamber filled with good dry wood char-

eoal, before being permitted to escape externally. It is also worthy of consideration whether some antiseptic solution such as a solution of carbolic acid might not be used with the lime in the pits, without injuring the value of the skin soaked there to the glue maker. Certainly some effeetual deodorant should be added to the waste lime and liquors before they are discharged from the pits and during removal from them. When deposited upon the premises the waste lime should, at least, be at once covered with some inches of fresh earth, and the removal off the premises should be effeeted in well-covered carts; or it might, when taken from the pits be at onee put into the covered carts in which it has to be removed. On Effluvium-Nuisances, by Dr. Ballard.

6th. The drying of glue pieces in the open air or under open sheds may be unobjectionable enough in certain localities and is highly objectionable in the close vicinity of inhabited houses. But it is an old-established practice, and I have seen no other followed anywhere. Nevertheless, it has appeared to me that the drying might be more expeditiously and equally well effected by some more civilised procedure. The use of heat for the purpose would probably be objectionable, but I imagine there could be no valid objection to drying the pieces in a moderately warm chamber through which air may be mechanically drawn or driven and then caused to pass through a sereen or cylinder of fresh wood charcoal before it is allowed to issue externally, so as to deprive it of offensive odour. Such an apparatus would be especially applicable for use in the winter months and in damp weather when glue pieces dry but slowly under the ordinary conditions.

7th. The remedies for nuisances from associated trades will be considered under the head of each particular manure-making trade.

The Manufacture of Fish-liver Oil.

The Manfacture of Fish-liver Oil.

Establishments visited.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 22, 1875	Head - -	Stonehouse, Plymouth.	Fellmongering, leather dressing.
„ 8, 1876	Deheer - -	Hull.	
„ „ „	Sisson - -	Sculcoats.	
„ „ „	Musk - -	Do. - -	Manufacture of artificial manure.

Process.

Oil is obtained from fish livers, *e.g.*, the livers of the cod or hake, by heating in an iron pan or boiler with a fire beneath. This is the mode in which I have seen it obtained in Hull and Plymouth. When the oil has sufficiently exuded, it is dipped off by hand and put into appropriate vessels. Sometimes the residue is transferred to a second pan to undergo a second process of heating, by which more oil (of inferior quality) is obtained. The final residue is then in some places placed in cloths and subjected to pressure in a screw or hydraulic press, in order to get out the last portions of oil. The mass (or the residue if not pressed) is set aside for conversion into manure either on the premises or elsewhere. The operation is carried on mostly in closed buildings, and the pans are usually covered and the eovers luted down. The vapours which pass off through cracks in the luting or when the covers are taken off and the oil or refuse removed, is inexpressibly offensive. The odour adheres to the person and clothing for a long time after

Offensiveness.

a very few minutes visit to one of these houses. I think the offensiveness is greater even than that of the process of gut scraping, which is one of the most offensive processes that I am acquainted with. Under bad arrangements the offensive smell extends for some distance round the works and is very nauseating. I myself on one occasion of a visit to such an establishment had the greatest difficulty to restrain vomiting, and the memory of the smell almost makes me feel sick as I recall it.

Sources of nuisance.

The sources of nuisance may be: 1st. The vapours proceeding from the boiling pans when open for dipping, &c., and during the process of dipping and removal of refuse, or escaping from the pans through cracks in the luting. 2nd. A general offensive odour proceeding from filthy and uncleansed premises. 3rd. Accumulations of refuse matter. And 4th. The manufacture of fish manure from the refuse upon the premises.

Modes of preventing nuisances.

The remedies applicable to the nuisances from this offensive business are as follows:—

1st. The process should always be conducted in a closed building, and never in the open air or under an open shed. At Deheer's manufactory in Hull I found the vapours from each covered boiling pan conducted by a pipe passing through the wall of the building to an ordinary worm condenser outside. Such vapours as were not thus condensed were carried into a fire. The watery matters condensed were collected in a barrel and from time to time run off into a drain. The principle of this arrangement, viz., condensation of so much of the vapours as might be condensible and burning of such vapours as remained uncondensed, is good, but in practice has not been very satisfactory at these works in consequence of imperfections in details. Offensive vapours still passed out through cracks in the luting of the pan covers, showing that there was no traction influence exerted by the fire upon the vapours within the boiling pan. It would have been better to have arranged that the vapours should actually have been drawn off from the boilers through the condenser to the fire. The Medical Officer of Health also informed me that nuisances arose sometimes in adjoining dwellings from the condensed liquors discharged into the drains, and the escape of offensive odours from imperfectly trapped inlets in and about the dwellings. At Musk's establishment in Sculcoats a different method of avoiding nuisance is in use. The building in which the boiling is carried on is carefully closed up, the only supply of air being from a lantern louvre in the roof and a pipe passing through the roof to the height of about 40 feet. The openings of the fireplaces are all within this building, and all air which the fires require must be drawn from the interior of the building through the ash pit. This so far as I can see has been effectual. There was less offensive smell too within the building itself than in other similar works I have visited, due, I believe, to the stricter observance of cleanliness. I am disposed to think also that the process would be less offensive than it is, if the boiling were carried on in steam jacketed pans, since there would be less risk of burning the contents of the pan than where an open fire is used. It would be well also to cover the boiling pans with a large hopper, so as to catch and convey away to a sufficiently tall chimney such vapours as arise in the process of dipping, and to dip the oil from the boilers into a funnel placed beneath the hopper, from which funnel a pipe should convey the oil to a covered tank. The offensiveness arising from the removal of the residue might be in a measure avoided by allowing the residue to cool before removal: and the pressing of the residue might be effected in a close chamber communicating by a pipe with a fire or tall chimney, as recommended for greaves pressing (p. 99).

2nd. A remedy for much of the nuisance arising from the second class of sources would be found in a proper construction of the building and in the observance of scrupulous cleanliness. The floor should be laid with cement or some other even, jointless material, and after each day's work should, as well as the tops and sides of the boilers, be cleansed thoroughly with hot water and soda, so as to remove all grease; and the inner walls and ceilings should be frequently and periodically lime-whited. The yard and outside premises generally should also be kept clean and free from litter of refuse, &c.

3rd. The refuse from the pans should be conveyed, if necessary, from one part of the premises to another in impervious vessels closely covered down, and daily cleansed; and, so long as it is retained upon the premises, should be retained in such vessels and removed from the premises in them.

4th. The remedies applicable to the manufacture of manure will be mentioned when the subject of manure-making comes under consideration.

Fat Melting. Dip-candle Making.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 3, 1875	Brown - -	Whitechapel.	
„ „ „	Symes - -	Belle Isle.	
„ „ „	Featherstone -	Do. - -	Butterine-making.
Dec. 11 „	Abel - -	St. George's Southwark.	Bone boiling.
„ „ „	Hoare - -	Do. -	Do.
„ „ „	Anderson and Cattley.	Do. -	Soap making.
„ 18 „	Tucker - -	Plymouth -	Distillation of palm oil, composite candle making.
Jan. 10, 1876	Potts - -	Southampton.	
„ 18 „	Furlong - -	Bristol - -	Bone boiling, manure making.
„ „ „	Thomas & Co. -	Do. - -	Soap-making, alkali making. Distillation of palm oil, &c., composite candle making.
„ „ „	Lyddon - -	Do.	
„ 19 „	Roger Moore -	Do. - -	Soap-making.
„ „ „	J. B. Moore -	Do.	
„ 20 „	Matthews & Co. -	Do. - -	Manufacture of railway grease, black varnish, and soft soap; oil-boiling.
„ 21 „	Lawson and Phillips.	Do. - -	Soap-making, alkali making.
„ „ „	Skull - -	Do. - -	(Rendering lard.) Bacon curing.
„ „ „	Dole - -	Do. - -	(Do.) do.
Feb. 12 „	Burgess - -	Warrington.	
„ 23 „	Harris - -	Stratford - -	Bone boiling.
„ „ „	Seaborne - -	Do. - -	Do.
April 1 „	Fitch - -	Melton Mowbray -	Fellmongering, splitting pelts.
„ „ „	?	Melton Mowbray.	
„ 6 „	Stevens - -	Loughborough.	
„ „ „	Ball - -	Do.	

ESTABLISHMENTS VISITED—*cont.*

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
April 11, 1876	Drackley - -	Market Bosworth.	
„ 24 „	Matthews - -	Ashby-de-la-Zouch.	
„ 26 „	Brown - -	Nottingham.	
„ „ „	Mackley - -	Do.	
May 17 „	Higgins - -	Manchester.	
„ „ „	Gatenby & Co. -	Do.	
„ 30 „	Sudlow - -	Salford.	
„ „ „	Thom & Co. -	Pendleton -	Soap-making.
June 1 „	Hargreaves -	Leeds - -	Bone boiling; preparation of potted meat.
„ „ „	Watson & Co. -	Do. - -	Soap-making, tripe boiling, &c.
„ 8 „	Holmes - -	Reading.	
„ „ „	Chancellor and Anderson.	Do.	
Aug. 16 „	Saunders - -	Cheltenham.	
„ „ „	Grace - -	Do.	
Nov. 15 „	Boulding - -	Croydon.	
„ 16 „	Cook - -	Bow Bridge.	Soap-making.
„ 21 „	J. Knight and Sons	St. George-in-the-East.	Do.
„ 28 „	Bozley and Marchant.	Hereford.	
„ „ „	R. Cook - -	Do.	
„ „ „	Powell and Harman	Do.	
Dec. 4 „	McLellan - -	Glasgow - -	Soap-making, distillation of resin.
„ „ „	Brice & Co. -	Do. - -	Bone boiling, tallow pressing.
„ 8 „	Barron - -	Sculcoats, Hull -	Bone boiling, flesh boiling, manure making.
„ 13 „	Pickering -	Birmingham.	
Jan. 10, 1877	Doudney & Co. -	Portsmouth -	Soap-making.
„ 30 „	Thomas Harris -	Calne - -	(Rendering lard.) Bacon curing.
„ „ „	C. Harris & Co. -	Do. - -	(Do.) do.
Mar. 6 „	Price & Co. -	Battersea - -	Soap-making, purification of paraffin, distillation of palm oil, &c.
„ 15 „	Bond - -	Barnwell, Cambridge.	
Other bacon-curing establishments.			

Materials used.

The proeesses whieh I inelude under this head are the "rendering" of butchers' fat for the making of tallow, of kitchen stuff, *i.e.*, fat eollected from various sources by "marine store-dealers," the rendering of pigs' fat for making lard, and other similar processes carried on in conjunetion with various trades for the utilisation of waste fat. The most important kinds of fat melting, so far as the production of nuisance is concerned, are the two first above mentioned.

Butchers' fat.

Butchers' fat is sometimes purehased directly from the butchers, sometimes it is purchased at a fat and skin market. It consists indiscriminately of beef and mutton fat. Sometimes on arriving at the fat-melter's he sorts it, selecting the best pieees of fat for making a superior article, sometimes melting beef and mutton fat separately for speeial purposes. The condition of freshness or taint in whieh the fat reaches the melter depends partly upon the weather, partly upon the time which has elapsed since killing, and partly upon the way in which it has been kept or packed.

"Kitchen-stuff" consists of all kinds of domestic refuse fat, the skimmings of pots in which meat has been boiled, fat from cooked, or uncooked meat, bacon rind, ends of tallow candles, dripping, and sometimes portions of meat, &c. The condition in which this heterogeneous mixture reaches the fat-melter depends again partly upon the weather, and partly upon the time it has been in course of collection in houses, and the further time it has been kept by the marine store-dealer. On Effluvium-Nuisances, by Dr. Ballard. Kitchen-stuff.

In some establishments the "rendering" is confined to butchers' fat, in others to kitchen-stuff, but in many establishments both kinds of fat are rendered.

Some soap-boilers render butchers' fat only, or both this and kitchen-stuff; dip-candle makers invariably render butchers' fat and commonly some kitchen-stuff as well, for the manufacture of candles.

The proeess of fat-melting, as usually pursued, is as follows :— Process of fat melting.

1. When the melting of butchers' fat is to be effected by a fire beneath the pan it is necessary to chop the fat. This is sometimes effected by means of a slicing machine which cuts it into thin slices, sometimes by hand with a long-handled chopper, the fat being laid in a wooden tray. In the latter case it is very roughly chopped. It is then discharged, usually down a hopper, into the pan. When steam and sulphuric acid are about to be used it is not considered necessary to chop the fat previously, but it is thrown into the pan or tank in the condition in which it arrives.

2. The modes of fat and stuff melting in ordinary use are,—*a*, by means of an open fire; *b*, by means of free steam; and *c*, (at some few works) by means of a steam-jacketed pan.

a. The material to be melted is thrown into a pan set in brickwork, open or more or less covered, as the case may be, and the pan is heated by a fire beneath. During the melting a workman stirs it with an iron stirrer to prevent, as far as possible, the burning of the material at the bottom of the pan. By fire.

b. The other method consists in adding to the fat, in an open or covered tank, a certain quantity of sulphurie acid, and throwing in steam by means of a perforated branched pipe reaching to the bottom of the vessel. In this process it is necessary to use a lead-lined tank. At Anderson and Cattley's soap works in Southwark, at Gatenby & Co.'s factory in Manchester, and at Harris's fat and bone works at Stratford, kitchen-stuff at the former and butchers' fat (sliced) at the two latter are melted by free steam without the use of acid. Stirring is not necessary since the ingress of the steam produces sufficient agitation. By steam and acid.

c. At Pickering's candle factory in Birmingham and Saunders' candle factory in Cheltenham, as well as at Featherstone's butterine factory at Belle Isle, all the butchers' fat used is rendered in steam-jacketed pans, and at J. B. Moore's at Bristol the same arrangement is in use for the remelting of spoiled candles, and again at Dole's bacon factory in Bristol for the rendering of lard. By steam-jacketed pans.

3. The rendering being completed, the tallow is usually ladled out by hand into another vessel where it may settle. In some candle works the tallow is ladled out upon a strainer, through which it runs into the receiving vessel, or a wire straining cage is lowered into the pan and the tallow is ladled out of this. In all cases, however, the receiver is an open vessel.

4. When all the fat which can thus be conveniently removed has been ladled out, the residue in the pan has to be dealt with. When the melting has been effected by an open fire or by steam without the addition of acid, this residue, which consists of portions of skin, meat, tendinous structures, &c., is put into cloths and subjected to pressure in Greaves pressing.

either a screw or hydraulic press; the remaining fat is thus pressed out, and the solid matter is converted into a dry cake known as "greaves." The residue from steam melting with sulphuric acid is so broken down that it is useless for greaves making. Sometimes it is pressed, however, but the product is only fit for manure making; but usually it is sent away as it is, or is converted with gypsum or other materials into a kind of manure upon the premises of the fat-melter.

5. When the tallow thus made is going to be used for soap-making, nothing further is done with it, but when for candle-making it may be subjected to other processes. It is, for instance, sometimes washed by heating it with some water either by an open fire or by free steam. The object is to wash out the acid; any impurities which may be present settle with the water when the tallow cools.

6. When tallow for candles is to be bleached, the operation is usually performed by melting by means of free steam in a lead-lined tank with peroxide of manganese and sulphuric acid, and by subsequent washing as above.

Special modes of rendering.

There are, however, other methods of rendering, for special purposes, in use by certain manufacturers, and two of these are worthy of particular mention.

At Dole's, Bristol.

One of these is by the use of a digester or strong iron cylinder. Such a digester is used by Mr. James Dole, of West Street, Bristol, for reducing and extracting the fat from various refuse morsels of fat, bone, or skin which accumulate in the course of his business as a pork butcher. The apparatus was constructed for him by Mr. Miles, engineer, of Bristol, who has been good enough to furnish me with a drawing and description of it. (Plate 7.) The apparatus consists of a strong iron cylinder provided above with a charging hole closed by a sliding cover, a man-hole towards the lower part for the discharge of solid refuse, and various taps at different levels for drawing off fat, &c. A pipe brings in steam at a pressure of 60 to 80 lbs. on the inch, below a false bottom, and another pipe at the side supplies water when requisite. A vent cock above serves to regulate the pressure and permits of the blowing off of steam. The apparatus being charged, steam is thrown in for about six or eight hours. If a heavy charge has been introduced the fat can be drawn off by one of the uppermost draw-off cocks. It can, if requisite, be floated to position for drawing off by turning in water through the water-feed valve. Where only a light charge is used, it is considered better to draw off into a tub all the liquid matters, which consist of water and fat together, by the lowermost tap, and to skim off the fat when it is cold. This apparatus extracts gelatine as well as fat, and any bones introduced with the charge are rendered perfectly friable. The steam discharged from the vent pipe can be conveyed away, if it be necessary for the avoidance of nuisance, in the event of matters used in the digester being productive of offensive vapour.

At Cook and Hall's, Bow-bridge.

The other arrangement is one patented (April 1875, No. 1,501) by Messrs. W. Cook and S. Hall, of the East London Soap-works, Bow, for the production, from the freshest beef suet, of a fat which is used for the manufacture of butterine. The fat is first thoroughly disintegrated and reduced almost to a pulp in a mill of peculiar construction, and is then dealt with as follows. There is a wooden chamber or closet provided, high enough for a man to enter and work in, with a passage up the centre. At the two sides are racks inclined a little from above downwards, and on to these racks are slid in from the outside, after the manner of drawers, shallow iron trays, which, when slid in, slope downwards towards the central passage of the chamber. Below the free lower edge of each row of trays there is an

open iron gutter or channel which, with other similar channels, communicates finally with a pipe leading to a receiver outside. The comminuted fat is laid in thin layers upon these trays, and the temperature of the chamber is by means of steam pipes raised to about 120° Fahr., or to such a heat as shall be just sufficient and no more to liquefy the fat, which then runs off into the gutter and is conveyed away to the receiver outside, leaving behind only such shreds and small portions of tissue as are not liquefiable by heat. The product is remarkably fine and fit for food. The residual matters still contain from 6 to 7 per cent. of tallow; they are mixed with kitchen stuff and rendered by the steam and acid process.

Process of dip-candle making.

In making dip candles, a small oblong dipping vessel is used to contain the tallow, which, as it is required, is ladled out of a pan in which it is remelted usually by a fire beneath. The temperature of the tallow is at first only just high enough to impart fluidity, but the last dippings are made in tallow thoroughly melted and quite fluid. In the winter it is sometimes necessary to prevent the too rapid cooling of the tallow by putting a small pan of charcoal or a lamp or gas jet beneath the dipping vessel.

Nuisance from fat-melting.

Fat-melting for the manufacture of dip-candles is a process which appears to be carried on in most towns, and is often a source of more or less serious nuisance. Fat-melting houses are commonly situated in the oldest and dirtiest parts of towns. The reason appears to be that, in former years, when there was less intercommunication between towns than there is now, and when tallow candles were in more common use, their manufacture in towns was almost as much a necessity as town slaughtering. Very many of the melting-houses I have visited had, I found, been established in the same premises for half a century or a century, and I found too that often no alteration had, during that long period, been made in the character of the process or of the plant. Towards the close of last year I was instructed to advise the Town Council of Southampton, who had asked for assistance of this kind, as to the best mode of dealing with a fat-melting nuisance in the very centre of the town. The Town Council had received a memorial from householders in the High Street, urging them to procure them relief from the disagreeable and sickening smell of the establishment referred to. The smell extended (as I have known to happen in many other instances) for 100 yards at least beyond the premises. Now this was an old-established melting-house, the nuisances from which had been borne with for a great many years, but were at last felt to be tolerable no longer. And this, from what I can learn, is the sort of history attached to most melting-houses that sanitary authorities have had to deal with. The nuisance is borne with until some habitual neglect of ordinary precautions on the part of the fat-melter leads to a cry for its summary and complete suppression.

Injury to health.

I have not been able to discover that any other injury to health has been attributable to the fat-melting nuisance than that dependent upon its disagreeable impression on the senses. In hot weather, especially, the smell of melting fat is, from its associations, unpleasant and even nauseating to some delicate persons, who at that season are unpleasantly impressed even by the smell proceeding from their own kitchens. In the Southampton case above referred to, one person stated that his workwomen had to give up their work in the summer time, in consequence of their health being injured by the closeness of the room arising out of the necessity of keeping the windows shut to exclude the intolerable smell. Others complained of being made sick, and one lady, not generally a delicate person, of frequently suffering from diarrhœa after about half an hour's exposure to the smell.

On Effluvium-Nuisances, by Dr. Ballard.

The following are the sources from which nuisance from a melting-house may arise:—

Sources of effluvium nuisances.

1. An offensive smell may proceed from the store-room into which fat is received. When it contains any considerable quantity of stale and semi-putrid fat, it may under some circumstances be a nuisance to near neighbours. This, however, is a minor nuisance.

2. The vapours from the melting-pan itself may be the source of nuisance. This is especially the case when the rendering is effected by a fire under the pan, for then any neglect of stirring may result in some over-heating of the pan and partial charring of some of its contents. Sometimes, when the pan is nearly empty, actual ignition has taken place; this is not only dangerous but occasions an exceedingly foul odour from the burning material. The vapours from the pan are most disagreeable when the fat is stale or semi-putrid, and when stale kitchen stuff or stale ship's fat are rendered.

3. A further source of nuisance may arise from the ladling out of the boiling fat or tallow into the strainer or vat into which it is removed from the melting pan. Even when means have been adopted for preventing nuisance during the actual process of rendering, this may still require attention. At such times, if there be a lid to the pan, the lid is raised and vapours escape freely, as they also do from the strainer and vat. The vapour is most offensive when the last portions are being removed, since these are then apt to become over-heated or partially charred.

4. Greaves pressing is also almost invariably a source of more or less nuisance, since it has to be performed while the tallow is liquid and hot enough still to give out offensive vapours.

5. Finally, many melting-houses are so filthy and the floors so encrusted with dirt and stale rancid grease as to give issue to a most disagreeable smell perceptible to passers-by; like that of stale fat on the premises, it is calculated to give offence under some circumstances to immediate neighbours.

Modes of preventing nuisances.

All these sources of nuisance are quite capable of prevention.

1. Offensive kinds of fat that can be covered up, such as kitchen-stuff, should be so covered, or stored in a chamber or closet communicating with the external air only through the medium of a screen containing wood charcoal. But it is a practice with fat-melters to spread out stale butchers' fat on the floor or on hooks in the store-room to sweeten by exposure to the air before putting it into the melting-pan. Where such fat is received and is so treated, provision should be made for its exposure in some part of the premises where it cannot be a nuisance to immediate neighbours. Fresh fat that is not about to be rendered immediately should be hung upon hooks in the store-room, and the cleaner and sweeter this room is, the more likely is the fat to remain sweet. In fact the method of preventing nuisance commences properly at the slaughter-house. As soon as it is removed from the animal it should be laid on racks where it may be freely exposed to the air, and it should not be packed until it is quite cold and hard. This is the practice pursued at Messrs. Cook's receiving house at the Deptford abattoir.

2. I am disposed to believe that the principal source of nuisance in rendering is occasioned by the offensive and semi-putrid condition of the material rendered. Whatever the method of rendering adopted, those establishments are least complained of which are the most particular in melting nothing but very fresh butchers' fat. Still the method of rendering has a great deal to do with the amount of nuisance. Of the methods of rendering in common use, that by the use of steam, either

Steam rendering preferable to fire rendering.

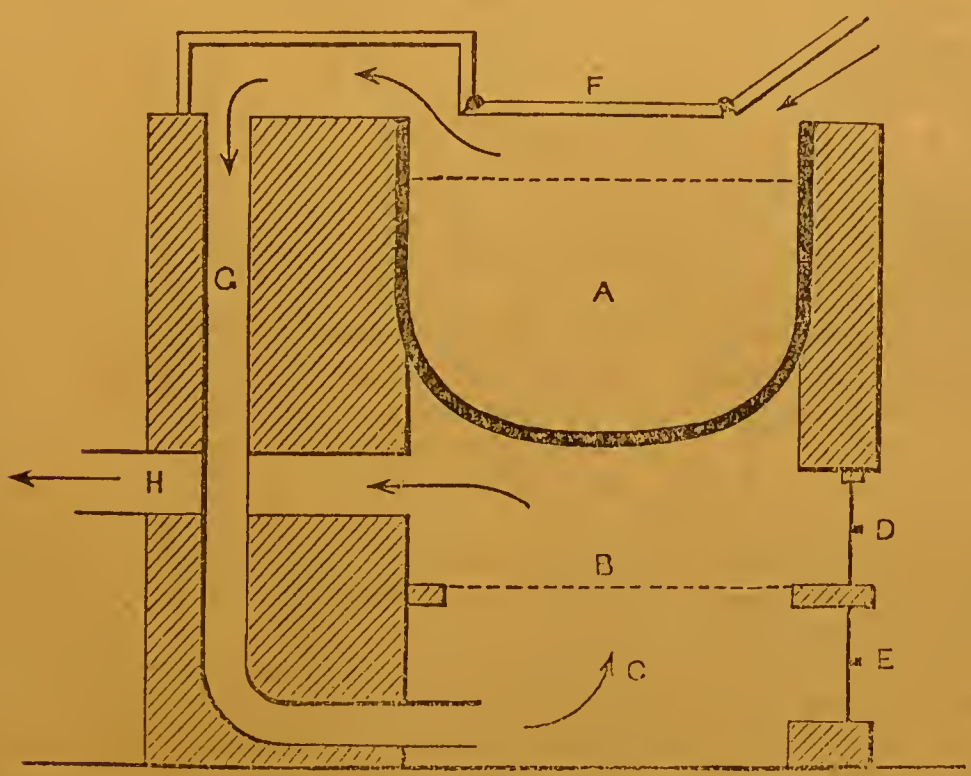
free or applied by means of a jacketed pan, is on the whole by far the least offensive, and in towns is the only method which, as a rule, should in my opinion be permitted. But by steam melting, when sulphuric acid is used, the profit from the "greaves" (which is used as food for dogs and is worth about 16*l.* per ton) is lost. Rendering by a fire beneath the pan cannot, as I am given to understand by some melters, be avoided when one object is the saving of the greaves. This, however, is a mistake, since edible greaves may be made and are made at some establishments already mentioned, where steam rendering without the use of acid or by means of a jacketed pan is in use. The method of rendering by fire heat should be adopted only in localities where it can be no nuisance to neighbours, and should be confined to the rendering of nothing but the freshest butchers' fat. It is now a common practice to cover the melting-pans with an iron cover capable of being raised, provided with a hinged portion in front, which hinged portion can be raised for the purpose of inspecting the operation and stirring the contents of the pan, and by carrying a flue or channel from the space between the cover and the pan into the ash-pit of the fire. The ash-pit door being closed, the fire draws all the air it requires from the space above the pan, and is supposed to burn all combustible vapours.

On Effluvium-Nuisances, by Dr. Ballard.

Mode of consuming vapours from fire rendering.

The following diagram shows the arrangement referred to ; the arrows indicate the course of the air-current for the supply of the fire :—

Fig. 4.



A. Pan containing fat. B. Fireplace. C. Ash-pit. D. Door of fireplace. E. Ash-pit door. F. Double hinged cover or lid. G. Pipe from beneath lid to ash-pit. H. Fire-flue.

To a certain extent this is effectual, but the workmen have too much control over the arrangements to allow of it being in all cases fully effectual in preventing nuisance. (*See also* "Bone-boiling," p. 120.) Besides, it does not act at all in this sense when the entire lid is raised for ladling out the tallow. Neither is it constantly the case that the fatty vapours are so thoroughly consumed by the fire as to render them inoffensive. Hence, where this method is adopted, the flue from the fire should be conducted to a chimney of good height. This is done at Chancellor and Anderson's Candle Factory in Reading, where the method of melting by an open

On Effluvium-Nuisances, by Dr. Ballard.

fire is carried out without any nuisance, as the Medical Officer of Health informs me. The chimney shaft with which the flues from the fires at this establishment communicate is about 100 feet high. The necessity for raising the lid to stir the contents of the pan may in large works be avoided (and the rendering expedited also), as at Cook's Soap Works in Bow, and at J. Knight and Son's works in Old Gravel Lane, by the use of mechanical means, the shaft of a stirrer within the pan passing through the pan cover.

Mode of preventing nuisance in steam rendering.

Where none but fresh butchers' fat is used, rendering by free steam and a little sulphuric acid may be executed, even in open tanks unprovided with any special means of disposing of the vapours, with a very minimum of nuisance, or without the production of any nuisance at all. At Alderman Burgess' melting-house in Warrington, for example, which I visited on a day when the process was actively going on, I could perceive no offensive smell anywhere in the neighbourhood, and scarcely any smell, and certainly no disagreeable smell, from the tanks, even in the melting-house itself. And this melting-house is situated in a closely built part of the town. The same process in use at Higgins' establishment in Manchester is similarly conducted without nuisance, as I am informed by the Inspector of Nuisances of the district in which the works are situated. But still it is not practicable for a fat-melter always thus to obtain his fat quite fresh. Stale fat and kitchen-stuff, &c. must be melted by some one, and then the vapours even from the steaming process are necessarily offensive. The nuisances may in some such cases be obviated by covering the rendering tanks and conducting the vapours into a high chimney shaft. This is the plan adopted successfully at Sudlow's establishment at Salford. At this place the chimney shaft is 100 feet high, and being connected with two furnaces has a strong draught. Or the vapours may be driven by a fan or drawn by the chimney draught through a fire before being discharged. This method may be seen in use at Harris's bone-boiling and melting-house at Stratford, and at Watson & Co.'s large soap works in Leeds, at both which establishments (the former a comparatively small one) a fan is in use to draw off the vapours from the covered tanks, and drive them through the boiler fires. The health officers of both these places tell me that no nuisance from the rendering arises at the works referred to. I have especially mentioned Watson's, because this method of disposing of the vapours from all parts of his large premises (where soap boiling and tripe boiling are carried on as well as fat melting) was, I understand, voluntarily adopted in consequence of complaints of nuisance 150 to 200 yards off, which have not since recurred. The chimney shaft at Watson & Co.'s is 150 feet high.

Condensing arrangements.

At Lyddon's in Bristol I found an arrangement for effecting some condensation of the vapour before passing it through the fire. This manufacturer (a candle-maker) steams his fat in a close vessel, from the upper part of which a 12-inch stone-ware pipe conducts the vapours into a large underground tank or cistern of water (but not into the water itself), from which an iron pipe conducts them into the boiler fire and from thence to a chimney about 50 feet high. A nuisance, however, which has been a good deal complained of, arises in this case when the water of the tank is (about once in six weeks) run off into the drains. At such times an offensive smell issues from untrapped or imperfectly trapped drains in the vicinity. Brice & Co., in Glasgow, effect condensation also, but in a different manner. There is a long iron pipe freely exposed to the air and leading to the fire ; steam condenses in this and flows down to the lowest part of the pipe near the fire, where a short descending portion of pipe, narrowed at the lower open end, permits of

the discharge of the condensed water. The principle being maintained, such a pipe might if requisite be connected with a worm condenser, or carried to any distance round the outside of the building (as is done in some sulphate of ammonia works) before reaching the fire. The collection of condensed water in this way would permit of any requisite use of deodorants before throwing it into the drain. In Mr. Cook's evidence given before the Select Committee of the House of Commons on Noxious Businesses in 1873, he stated that at his Hoxton works he, at that time, successfully dealt with the offensive vapours from his stuff-melting pans by a process of condensation. He passed them through a flue filled with coke, upon which water constantly dripped from a pipe pierced with small holes; from this flue the vapours were driven by a fan into the ashpits of the steam boilers and through the fire.

Applicability of steam rendering to soap works.

I must here add a few words upon the applicability of steam rendering to the use of the soap boiler and candle maker respectively. It is now by no means an uncommon practice with soap boilers to render the fat they receive for soap making by the free steam process. I need merely instance Anderson and Cattley in Southwark, Thom & Co. at Pendleton, and Watson & Co. at Leeds, as large firms who follow this practice. And all large soap makers melt out the tallow which they purchase in casks by means of free steam. But the following portion of the evidence given by a soap boiler (Mr. E. Knight), before the Select Committee of the House of Commons on Noxious Trades in 1873, appears to indicate that all soap boilers are not agreed upon its applicability:—

Mr. Knight's opinion.

"(2967.) How is this melting conducted in your instance, by open fire or by steam?—By fire; the butchers' fat by fire, and the kitchen-stuff also by fire.

"(2968.) You dissolve by steam the major part of the fat, which you receive in tubs, do you not?—No, the major part we do by fire, not by steam.

"(2969.) Do you use steam for that purpose at all?—No, not for our butchers' fat.

"(2970.) Could you use steam for the whole process?—No, we could not."

Mr. Knight, from his extensive experience, is so important an authority that I thought it right to visit his works in Old Gravel Lane, and to learn more fully his views upon this subject. He makes at these works both yellow and mottled soap, and for the yellow soap the only tallow used is that which he makes from butchers' fat, except when he has not sufficient of such tallow on the works, and then tallow made from kitchen-stuff is used in addition. As a rule the latter kind of tallow is only used for the manufacture of mottled soap. Both kinds of material are (for soap-making purposes) rendered in the same way, namely by fire heat; the pans are closely covered and the contents stirred by machinery during the rendering. The only difference is that the vapours from the rendering of butchers' fat are conveyed at once into a chimney shaft about 54 feet high, while those from the kitchen-stuff are first conducted into the ashpit of the fire and through the fire on their passage to the chimney. The explanation given me by Mr. Knight as to his statement of the inapplicability of steam rendering to his processes was, that at his works a superior kind of yellow soap of superior hardness is made, and that he has besides the advantage of the profit arising out of the manufacture of greaves. He tells me that, at the time he gave the evidence in question, he was under the belief (a belief which he held in common with other old soap-boilers) that the superior hardness of his soap was in some way really dependent, in part

at least, upon the use of fire-made tallow, but that he is now quite satisfied that this is not the case, and that equally good and hard soap may be manufactured from tallow made by the steam process.

Applicability of steam rendering to candle making.

When first I commenced this inquiry, I had had no experience in steam rendering for the preparation of tallow for candle-makers. All the fat-melting I had seen in candle-houses, up to that time, had been effected by a fire under the pan, and the manufacturers told me that steam melting would not answer their purpose, since the tallow produced was not sufficiently "strong." I hesitate to say that this opinion is altogether the result of prejudice, since one manufacturer told me that, while he made tallow for ordinary dip candles by the steam process, miners insisted upon having candles made with fire-made tallow for use in the mines. But they also insisted upon having them coloured green. I have repeatedly questioned candle makers who use steam-made tallow upon the subject, and they assure me that candles made from such tallow are quite as good as those made from fire-made tallow. The first conversation I had upon this matter was with Mr. Phillips, of the firm of Lawson and Phillips, Bristol. Mr. Phillips, although now a soap-boiler, was formerly a candle-maker. He assured me that the only ground on which steam-made tallow could be regarded as less "strong" than fire-made tallow was, that it might (as in the winter) have some watery matter entangled in it, and in that case all that is necessary is to remelt the tallow at about 212°, and to keep it thus liquid for a short time. But even this appears to be not always necessary, since I have frequently seen candles, which burned well without "spitting," made of steam-made tallow which had undergone no such previous preparation. Mr. Knight, of Old Gravel Lane, who makes dip candles as well as soap, renders fat for this purpose (candle-making) by the steam and acid process, and bleaches with bichromate of potash. But he agrees with many candle-makers in saying that the tallow so made is "less strong," and the candles made from it are more apt to gutter than candles made from fire-melted tallow. Nevertheless they fetch he says the best price.

Mr. Duncan Knight agrees with Mr. Phillips in the opinion that the "strength" of the tallow may be fully restored, however, by driving off the water it contains, when thus made, by heating to 212°. It has been suggested to me, from another source, that possibly the alleged less strength of steam-made tallow may be dependent upon the solution of gelatinous or other animal matters out of the non-fusible elements of the fat. It is probable, however, that the subsequent heating would, by driving off the water they are associated with, render even these matters innocuous or no more injurious to the tallow than the non-fusible animal matters contained always in fire-made tallow.

Rendering by free steam without acid or by close steam, as in a jacketed pan, is, equally with steam and acid rendering, preferable to rendering by fire, so far as the production of nuisance is concerned; but the vapours will be offensive even with the adoption of these processes, if the fat be stale and tainted. Hence similar precaution against creating nuisance ought to be taken. But, if there be anything in the opinion before referred to as to the "less strength" of steam-made tallow, the objection would not, I imagine, apply to tallow melted by close steam.

Cook's process instructive.

Rendering by Cook's patent process is a proceeding wholly devoid of nuisance, and it appears to me that (setting the details of the process aside) the principles on which it is founded have an important application to the rendering of fat for other purposes than butterine making. These principles are the fine comminution of the fat prior to rendering, and the effecting of the rendering at a low temperature—a temperature insufficient to cause offensive effluvia by the action of the heat upon the fat and non-

fusible tissues. The success which has attended Mr. Cook's process leads me to suggest that, by taking the trouble to thoroughly comminute the fat used, ordinary fat melting might probably be effected readily and speedily by close steam at a comparatively low temperature by those who from prejudice (or even on substantial grounds, if there be any such) object to use the free steam process. Mr. Duncan Knight tells me that at Old Gravel Lane they once attempted to comminute for making a superior material for exportation to Paris, by means of toothed rollers working into each other in pairs; but that the process was slow and laborious, and that the teeth of the rollers were apt to be broken by portions of bone or other harder matters occurring in the fat: but this is a difficulty which a little modification of the machinery might overcome.

3. The only mode that I know of by which the nuisance arising during the removal of the tallow from the melting-pan, when fire heat is employed, can be lessened, consists in raking out the fire or reducing it to a minimum during the process, and by the erection of a large hood over the pan and receiving vat which shall conduct the vapours given off into a tall chimney. Great care is necessary, more indeed than workmen can for the most part be trusted to give, so as to avoid nuisance even thus. But from what I heard at Nottingham from the Inspector of Nuisances there, the provision of such a hood at some works I visited, and which had previously been complained of, has proved effectual. But for the reason above assigned it is not to be recommended. The difficulty of carrying out this part of the process without nuisance is an additional reason why steam rendering should be the only method adopted in towns and populous places. Where steam is used, the rendering tank being sufficiently elevated, the tallow may be run out by a pipe and tap from a part of the covered tank sufficiently distant from the bottom to avoid the dregs and water, which deposit after the steam has been shut off long enough for the tallow to clear itself of them. This plan may be seen in operation at Lyddon's in Bristol (comparatively small works), and at Watson & Co.'s, Leeds (one of the finest and largest works of the kind in the country). I once heard a theoretical objection raised to this, viz., that the pipe would become choked with consolidated tallow; but in practice I have not seen this accident happen, nor has it ever been mentioned to me by fat-melters who run off their tallow thus. Should it occur, the pipe might readily be cleared with a cane, or the accident be prevented altogether by a steam jacket to the pipe. But, under ordinary circumstances, where fresh fat only is used and sufficient steaming given to it, the tallow may be ladled out in the ordinary way without nuisance. Steam melting also appears, so far as my observation has gone, to save the necessity of straining the tallow. Most of the dregs settle in the receiving tank, and what little may remain are removeable by subsequent settling or by washing and subsidence.

4. The nuisance arising from "greaves"-pressing also disappears with the adoption of the steam and acid process. In cases, however, where greaves must be pressed, the nuisance must be abated by closely boxing up the press and the receiving vessel, and by conducting the vapours by a pipe into a fire or tall chimney shaft.

5. Cleanliness is the remedy for the fifth source of nuisance which has been referred to. Most of the melting-houses I have visited, especially the smaller, I found to be indescribably filthy, and the floor and steps dangerous from the slipperiness arising out of years upon years of in-trodden grease and dirt. Some were very old and dilapidated premises, which appear as if they had never been cleaned or whitewashed from the time of their establishment as melting-houses. In such places the scraping and cleansing of the floors, &c., would be, I should think,

On Effluvium-Nuisances, by Dr. Ballard.

a source of actual profit, since the grease is easily recoverable, or might command a ready sale for recovery. A melting-house is not by any means necessarily a dirty place, nor need the process be carried on in a dirty style. To such as may desire to be convinced of this, I recommend a visit to Chancellor and Anderson's, at Reading, where the melting-house and candle-house are as clean and tidy as the well-conducted kitchen of a gentleman's house.

THE MANUFACTURE OF SOAP.

THE MANUFACTURE OF SOAP.

Establishments visited.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Dec. 11, 1875	Anderson and Cattley.	St. George's Southwark.	Stuff-melting.
„ 21 „	Victoria Works -	Plymouth.	
„ „ „	Millbay Works -	Do.	
Jan. 18, 1876	Thomas & Co. -	Bristol - -	Fat-melting, alkali making, distillation of palm oil, &c.
„ 19 „	Roger Moore -	Do. - -	Fat-melting.
„ 20 „	Matthews & Co. -	Do. - -	(Soft soap), fat-melting.
„ 21 „	Lawson and Phillips.	Do. - -	Fat-melting, alkali making.
Feb. 21 „	Crossfield -	Warrington -	Alkali making.
May 16 „	Vickers and Son -	Manchester -	Bone-boiling, size making, manufacture of artificial manure and sulphuric acid, &c.
„ 30 „	Maguire - -	Salford - -	Tar distilling, manufacture of cart grease and sulphate of ammonia.
„ „ „	Thom & Co. -	Pendleton -	Fat-melting.
June 1 „	Watson & Co.	Leeds - -	Fat-melting, tripe boiling, &c.
„ 15 „	Duckworth -	Salford.	
Nov. 16 „	Cook - -	Bow Bridge -	Fat-melting.
„ 21 „	J. Knight and Sons	St. George's-in-the-East.	Fat-melting, and candle making.
Jan. 10, 1877	Doudney & Co. -	Portsmouth -	Fat-melting.
Mar. 6 „	Price & Co. -	Battersea - -	Fat-melting, purification of paraffin, distillation of palm oil.

Materials used.

The materials now used generally in soap-making are a caustic lye of soda or potash, and various animal or vegetable fats or oils. The soda lye is made from soda ash (a crude calcined carbonate of soda, manufactured at the alkali works chiefly in the North of England and in Scotland,) by means of quicklime. Potash lye is similarly made by the action of lime upon dissolved crude carbonate of potash. The animal fats employed are chiefly tallow, either imported from abroad, *e.g.*, from Russia, Norway, Canada, Australia, South America, &c., or manufactured at home by rendering butchers' fat or kitchen stuff. Fat produced by the boiling of bones and from the skimming of glue pans and other kinds of refuse fat from different trade processes are also used. What is known as ship's fat, also used by some soap-boilers, is fat which has been rendered by ships' cooks, during voyages, from the refuse fat of the

food consumed on board. Fish oils are used for the manufacture of some kinds of soft soap. The vegetable fats or oils used are principally palm oil, cocoa-nut oil (both solid substances), and cotton seed oil. Rosin or colophony, which is not properly a fat, but is capable of combining with alkalies, is also used. So also are some other materials, such as silicate of soda, which need not be specially enumerated.

The fats and oils used in soap-making are, chemically, compounds of a fatty acid, stearic, margaric, oleic, palmitic, cocinic, &c., as the case may be, with glycerine as a base; and saponification chemically consists in causing the combination of these acids with soda or potash, the glycerine being eliminated. When these fatty acids are combined with soda they form a "hard" soap, and when with potash a "soft" soap. Process.

The process of rendering the alkali caustic by the use of lime is one which can by no possibility create nuisance, so that I need not describe it. But some soap-makers manufacture their own soda ash from salt cake which they purchase or bring from other works, even when they do not manufacture the salt cake on the premises. Crossfields of Warrington, Thomas & Co. of Bristol, and Lawson and Phillips of Bristol, do this.

The hard soaps made in this country are prepared from the various solid fats mentioned, and are of different kinds according to the use to which they are to be applied. The two most ordinary varieties are known as "yellow" and "mottled" soap. The use of rosin previously powdered is confined to the manufacture of yellow soap. Hard soap.

Some soap boilers themselves render the butchers' fat or kitchen stuff, the tallow from which they are about to use at their works; and some being bone-boilers also, manufacture the bone fat that they require. Others neither render fat nor boil bones, but use only such materials as arrive at their works in casks. The coarser kinds of fat, such as that made from kitchen stuff, ship's fat, &c., are used only, or almost only for the manufacture of the more impure (mottled) kind of soap. Legitimate mottling of soap results from the irregular diffusion through the mass of more or less oxide or sulphide of iron and of some little of the impurities of the fat. There is, however, another kind of mottling (very readily distinguishable) due to an artificial colouring material introduced into the soap.

At some works, the tallow, palm oil, or cocoa-nut oil used are dug with a spade out of the casks and thrown at once into the boiling pans; and at all works this is the mode in which ship's fat and rendered kitchen stuff is extracted from the casks. But in many large works it is now the practice to extract tallow and other solid fats from the casks by a process of steaming. The cask is laid upon its side and supported in this position, with the bung-hole downwards, over a tank, and a jet of steam is thrown in at the bung-hole. The fat as it melts runs out into the tank, from which it is pumped up into the boiling pans.

Palm oil is usually bleached before being used for soap-making. The methods of doing this which I have seen in use are: 1. The warming of the oil with bichromate of potash and sulphuric acid. 2. The raising of the oil in a strong iron cylinder heated by a fire beneath to a temperature of about 480° Fahr.; and 3. The heating of the oil in an open tank to about 200° Fahr. by means of close steam, and then blowing cold air through it by means of a fan or blower.

The boiling pans are large iron pans set in brickwork and capable of making at one time many tons of soap. The following description of the process of soap boiling given by Professor Church* is so concise that

* British Manufacturing Industries. London: Stanford, 1876.

On Effluvium-Nuisances, by Dr. Ballard.

I do not hesitate to quote it here :—"Some of the oil or fat, or mixture "of such matters, is first put into the pan, then some weak caustic lye "(sp. gr. 1·05 to 1·08) is added, the mixture being agitated and gently "warmed at first, further quantities of lye, of increasing strength, "being added from time to time, and the heating continued until a "kind of emulsion is formed, then fat (and rosin in making yellow "soap), and then more lye is added from time to time, while the boiling "is continued until the proper quantities and proportions of each have "been introduced, and the saponification, or action of the alkali upon "the fat, is complete. Precautions against excessive frothing and "boiling over have to be taken, while the completion of the change "must be ascertained by the occasional withdrawal and examination of "small samples from the pan. The next step of the process is the "separation of the soap from the mass of the liquor, a separation or "parting which is commonly made by the addition of about 10 lbs. of "common salt to every 100 lbs. of fatty matter employed. Soap being "insoluble in strong saline solutions separates in a nearly dry and pure "condition, floating to the top of the liquor. The layer of soap may "be drawn off, still melted or fused, at this stage of the operation, and "separates further into a clear portion and a mottled portion ; or the "more usual plan may be adopted, of running off the spent watery "and saline liquor below, leaving the soap in the pan to be afterwards "treated in the following way. To the soap is added more lye, and the "whole is once more heated, then the mixture is allowed to settle for "some hours. Next the liquor is run off to be used in the next charge, "while the soap, which now contains more water than before and a "slight excess of alkali, is cast in iron frames and moulds, and when "cold cut into blocks or bars by means of wires." Soap boiling is now usually effected by means of steam, either "free," *i.e.*, thrown directly into the pan, or "close," *i.e.*, led through a coil of pipe within the pan. At some works I have visited the first part of the boiling is effected by free steam, and the latter part by means of a fire beneath the pan.

Soft soap.

"Soft soap" is made by boiling with potash lye various kinds of fish oil, seal or whale oil, rape, linseed, or cotton seed oil, a little tallow being sometimes added to produce a speckled appearance in the finished product. Two or more of these several oils are sometimes used together, the price governing very much the kind of oil used at any particular time. The process is up to a certain point not dissimilar to that for hard soap. A lye of only moderate concentration is used first, and a sort of emulsion is formed which gradually loses its opacity and becomes more viscous. Excess of foaming is prevented by beating down the foam as it rises. More and stronger lye is then added until the soap remains transparent and viscous when cold. The whole is then boiled to expel excess of water, the material being constantly stirred. The soap, not being, like hard soap, separated by means of salt, contains when finished all the materials used in making it, in one form or another, except so much of the water as has been boiled off.

Effluvium nuisance.

Prior to the time (about forty years ago) when British alkali came to supersede commonly the use of kelp or barilla (prepared by the lixiviation of the products of combustion of certain kinds of sea wrack) the manufacture of hard soap was a very offensive process and used to give rise to much external nuisance. The waste liquors were especially disagreeable and it was customary to boil them down again for the recovery of the salts they contained and the production of "soapers' salts," and subsequently for making "black ash" by heating with lime and sawdust. This process was very offensive, it is said, from the evolution of sulphuretted hydrogen. But, since the use of British

alkali, all this offensiveness has been got rid of, and soap-making is now carried on in many places without creating nuisance at all, or with the production of very much less offensive effluvia than was formerly the case. Under existing circumstances the waste liquors are inoffensive, and can safely be run off into town drains. Nevertheless, it still sometimes happens that offensive effluvia from soap works are complained of by persons residing in their immediate vicinity. On Effluvium-Nuisances, by Dr. Ballard.

The sources of offensive effluvia may be one or more of the following :— Sources of nuisance.

1. The rendering of butchers' fat or kitchen stuff on the premises.

2. The melting of strong-smelling fats or tallows out of the casks by steam. Foreign tallows vary much in their odour, partly on account of their source, and partly, perhaps, on account of differences in the mode of their production. Some have a very disagreeable odour, and the vapours proceeding from their melting out are also very offensive. To some persons the smell proceeding from the melting out of palm oil or cocoanut oil is more or less disagreeable.

3. The bleaching of palm oil gives rise to the evolution of the irritating offensive vapours of acrolein, which where only small quantities of oil are dealt with may produce little or no annoyance, but which when large bulks of oil are dealt with may give rise to decided nuisance.

4. When fats which have an offensive odour, such as fish oil, are used, the vapours from the boiling pans may be very offensive and give occasion for complaints from persons residing near the works, who may be annoyed by the entrance of the offensive effluvia into their houses. One fat of this character is what is known as "ship's fat." When obtained from vessels which make only short voyages this fat is received at the works in a fresher and much less offensive condition than when it is obtained from vessels which make long voyages. In the latter case the fat has more or less of a bilge-water odour, smelling in fact more or less strongly of sulphuretted hydrogen, especially the fat in the lower parts of the casks; and when such fat is thrown into the pans and melted in the process of conversion into soap, the vapours are distinctly offensive. When sweet fats are used the vapours from the boiling processes are not offensive (some people call them aromatic and refreshing); but however this may be, it is not agreeable to be constantly exposed to them.

The soap being made, the after processes are inoffensive.

The only other probable source of nuisance at soap-works is the dealing with the tank-waste when soda ash is manufactured on the premises. The character of this nuisance will vary with the mode of dealing with this substance. (*See* "Alkali Making.")

I am not aware of any instance in which the effluvium nuisances from the actual process of soap making have been accused of producing injury to health.

The remedies for the effluvium nuisances arising from soap works are as follows :—

1. The remedies against the nuisances proceeding from the rendering processes have been considered in the section on fat-making. Modes of preventing nuisances.

2. The nuisance arising from the melting out of offensive tallow, &c. by steam, may be prevented by covering the whole space occupied by the receiving tanks, and the casks supported over them, with an iron cover capable of being raised or let fall by means of pulleys above, or by performing the operation within a close chamber. A pipe may be carried from the cover or chamber to the ashpit of a fire, or a fan may be used to draw off the vapours, when they may be dealt with either by a process of condensation or by passing them through a fire. For the purpose of condensation any one of the arrangements described in the

section on fat-melting may be adopted. The sort of boxing up above mentioned may be seen in operation at the soap works of Anderson and Cattley in Southwark, and Thomas & Co. in Bristol. The former have a communication between the exterior of the cover or closet (wooden) and the chimney shaft. At the latter works there is no such communication, but, the cover being of iron, the action of the cold air upon the outside probably causes the condensation of some of the vapours within. The iron cover at these works, resembling a large dish cover, dips at its lower edge all round in a shallow channel containing water, which thus forms a water lute. There would be no difficulty with such an arrangement as this (were it requisite) in facilitating the condensation by causing a spray of cold water to fall upon the outside of the cover.

3. The remedies applicable to the offensive vapour proceeding from the bleaching of palm oil will be described when the subject of refining and bleaching oils, and the manufacture of palmitic acid, comes under consideration. It may suffice to say here that the principles of the remedies lie in drawing off the vapours, and either passing them through a fire or condensing them by the agency of water.

4. Offensive vapours from the actual process of soap boiling are best dealt with on the plan adopted by Watson & Co. of Leeds. At these works all the boiling pans are covered over more than half their extent by wooden covers, from the back part of which a pipe conveys the vapour to a main pipe or channel leading to one of the boiler fires, where they are discharged into the mouth of the ashpit by means of an adaptation provided for the purpose. A fan, interposed in the course of the main channel, serves to draw off the vapours in such a way that none of them escape into the works.

The remedies for the nuisances arising from the dealing with the tank waste of alkali making will be treated of, when the subject of alkali making comes under consideration.

THE MANUFACTURE OF ARTICLES FROM BLOOD.

Establishments visited.

THE MANUFACTURE OF ARTICLES OF COMMERCE FROM BLOOD.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875	Smith - -	Islington.	
„ „ „	Hyland - -	Do.	
Jan. 5, 1876	Hales - -	South Bermondsey.	
Feb. 23 „	Hempleman -	Stratford.	
April 26 „	King - -	Sneaton, Nottingham.	
May 17 „	Walshe - -	Manchester Corporation abattoir.	Manure making.
„ „ „	Howarth - -	Manchester.	
„ „ „	Smith and Forrest	Do. - -	Distillation of tar and resin.
„ „ „	Laing & Co. -	Do.	Manufacture of British gum and starch.
„ 22 „	? - - -	Boy and Barrel Yard, Leeds.	Slaughtering.
Oct. 4 „	Lewis & Co., or Gall.	Glasgow.	
Nov. 15 „	Voultier - -	Croydon abattoir.	
„ 24 „	Do. - -	Bermondsey.	
Jan. 31, 1877	Coles - -	Near Calne -	Manure making.
Feb. 2 „	Riley - -	Plymouth.	
„ 5 „	King - -	Bristol.	
Mar. 28 „	W. & C. Forrest -	Brediland, Paisley	Gut scraping.

Blood collected in slaughter-houses is dealt with differently in different parts of the country, in preparation for different technical uses. It will be convenient, although not, perhaps, strictly orderly, to treat of all the processes to which it is subjected in the same section. On Effluvium-Nuisances, by Dr. Ballard.

Preparation of Blood for use by Turkey-red Dyers.

Preparation of Blood for Turkey-red Dyers.

At some places in the north and north-west of the country, I found that the blood, before it left the slaughter-houses, was beaten or stirred with a bundle of twigs to remove the fibrin. This was the practice I found at Hereford, and there I was informed that the defibrinated blood was purchased by cider merchants, probably for some clarifying purpose. At Glasgow where the blood at the public abattoirs is similarly defibrinated, the blood after having been thus treated is purchased for an establishment where it is prepared for use by Turkey-red dyers. The object of the process carried on at these works appears to be to bring the liquid blood to a uniform consistence, and to a definite strength by judicious dilution with water. The building in which the operations are conducted is a long shed or roofed building open only at one end (that furthest from the part where the principal operations are conducted). At the furthest end of the shed is situated a large tank, the top or cover of which forms a platform on to which the casks containing the blood are first of all hoisted. In this platform are trap doors leading to the tank below. Over one opening in the platform there is placed an inclined metal strainer into which the blood is first emptied directly from the cask. The more liquid part of the blood runs through into the tank beneath, while all portions of loose clot in the contents of the cask are arrested. This loose clot is collected in a tub, and, when a sufficient quantity of it has been collected, it is rubbed or broken down with water in a sort of mill or comminuting machine and run through the strainer into the tank. A sufficiency of water is mixed with the contents of the tank, which are then run off by a tap below into casks for sale. The floor below, on which these casks are placed to be filled, is paved, and underneath the pavement is a kind of cesspit or receiver partly open for collecting such of the prepared blood as may be spilt. The blood as it arrives in the casks and as given out from the works is commonly in a state of commencing or advanced putrefaction, and stinks horribly. Process observed at Glasgow.

At one time, as I am informed by Dr. Russell, the Health Officer of Glasgow, these works were a source of much trouble to the authorities on account of the effluvium nuisances proceeding from them. The stink was a subject of serious complaint at a distance as great as 150 yards, and it is still complained of occasionally. Besides the ordinary functional disturbances of nausea, loss of appetite, &c. produced by the noxious effluvia, I met with one person who assured me that exposure to them produced in him on several occasions attacks of diarrhœa which lasted for some hours. He very distinctly referred these attacks to the operation of the foul effluvia which entered his house from these works. Effluvium nuisances.

Improvements with a view to lessen the nuisance have been in great measure effectual. Near the part of the works where the processes are chiefly conducted, and again between this part and the entrance, a wide pipe has been laid along the roof, where the pipe opens downwards by a funnel-shaped aperture. This pipe leads to the ashpit of a furnace fire, provided for this sole purpose, having a chimney shaft about 100 ft. high, and a fan is provided in the course of the pipe to draw the air out of the works and to drive it through the fire. The efficiency of the arrangement would of course greatly depend upon the carefulness Mode of abatement of nuisances.

exercised in keeping up the fire; but at the time of my visit it was duly alight, and the fan was acting so efficiently that no offensive smell was perceptible within the building, except at the part where the principal operation was being carried on, and none outside.

Manufacture of Blood-albumen.

The Manufacture of Blood-Albumen.

Nature of the business.

This trade consists in the separation of the serum from blood-clot, and the drying of the former into transparent flakes of a reddish yellow colour, but varying in depth of colour according to the quality of the serum from which they are made. It is a trade which I believe has only risen up within the last quarter of a century. At the present time it is pretty extensively carried on in many places. Two firms alone, viz., that of King & Co. and that of Smith and Forrest, have each of them establishments in many of the large towns in the kingdom.

Process.

Blood-clot is absolutely worthless for the purposes of this trade, if it be not fresh. The more recently the blood has coagulated the more valuable it is for albumen making. Hence the blood-albumen makers make arrangements for the speedy collection of blood from butchers and town abattoirs, and it is dealt with immediately on its arrival at the works. Sometimes the first process, that of "separation" of the serum from the clot, is carried on in some part of a public abattoir. This is the case at Deptford, Croydon, Glasgow, &c. The serum is, in such cases, sent away in casks to the establishments where it is dried.

The blood arrives in the shallow iron vessels in which it is caught from the slaughtered animals, or in casks. The clot is immediately taken out and carefully sliced (when it arrives in shallow vessels it is sliced before removal from them,) and the slices are arranged upon iron strainers, each with a pan beneath to receive the serum which flows out as the clot continues to contract spontaneously. The season of the year governs the time during which this draining is prolonged. In the summer it is continued for about 12 hours, but in the winter for 18 or 24 hours. The strainers, each with its pan beneath, are arranged on racks in a building which is so constructed as to be kept as cool as possible. It is also important that the building should be in such a locality as to be free from vibration caused by the passage of heavy vehicles or railway trains. From the pans the serum is, in the best works, transferred into a settling tank, where it remains about two days, until all the red colouring matter, &c. which may be in suspension have been deposited. At some works, where an inferior article is made, the highly-coloured serum which comes with the clot in the casks is dried, and, after the clot has been drained, it is put into a cask from which the head has been taken out to separate in bulk still further, and the dark serum which exudes is run off for use.

The serum is then transferred into a series of shallow iron trays, which are arranged upon racks in a chamber heated with steam pipes to a temperature of about 120°.

When it is quite dry and brittle, the albumen is scraped from the trays and taken to the warehouse to be sorted and packed.

The waste clot usually is sent away either to the manure maker or to the blood driers, but is sometimes dealt with on the spot.

Effluvium-nuisances.

The well-known faint odour of blood always pervades an establishment of this kind, and is especially marked in the drying chamber, but it does not pass beyond it in any such way as to cause a nuisance, unless the manufactory be very badly conducted. Still from time to time such an establishment has become a nuisance. When I was Health Officer in Islington I had, on more than one occasion, to deal with

establishments of the kind, on account of repeated complaints of nuisances from them. Similar proceedings, I am informed, have been found necessary elsewhere. On Effluvium-Nuisances, by Dr. Ballard.

I myself have observed no ill effects upon health occasioned by the effluvia, nor have I heard of any produced elsewhere.

The two ordinary sources of nuisance from blood-albumen works consist:— Sources of nuisance.

1. In the effluvia of putrid blood arising from the exhausted clots retained on the premises prior to removal.

2. In the general disagreeable faint smell proceeding from the yard and premises, especially when due cleanliness is not observed.

3. In effluvia from other and further processes, such as blood boiling or blood-manure making, carried on upon the premises.

In one instance, in my experience, complaints were made of an establishment in Islington, the cause of the nuisance being the evolution of ammonia in the drying process. This was a good many years ago; and I found it resulted from the use of an ammoniuret of copper, which at that time was added to the serum before drying. I visited this establishment again during this inquiry, and was informed that the use of the ammoniuret had long been discontinued, no advantage having resulted from it.

As to the remedies for nuisances:—

1. It is a practice in some works to throw the exhausted clot into a clot-bin where it is left until removal. But now, in the best works, the clots are at once put into moderately sized casks, through a sufficiently large opening at one end, which, when the cask is full, is closely fastened down with a cover secured by screws. Modes of preventing nuisances.

2. Such works as these require to be conducted in a very cleanly manner. The yard should be well paved with stone, set so that no water may lodge upon it, and so that any offensive liquids that may reach it may not form pools, but flow readily away to the drain inlet. It should be kept at all times well swept up, and should be daily washed down with water. The separation room and the room in which the clots are sliced, when very near inhabited houses, should be closed in on all sides and ventilated at the roof, as recommended for slaughter-houses, and they should be well and evenly paved. The best kind of pavement that I have seen in use for such a room was one of cement. Flagstones are apt to crack or loosen, and the pavement to become uneven and thus liable to retain pools of liquid matters, or to the insinuation of these liquids between and beneath the stones. Nothing can be more objectionable than a wooden floor, such as I have seen in use at Leeds. The floors should be frequently scrubbed and cleaned, all the vessels and implements used ought to be regularly cleansed, and the whole interior of the buildings periodically lime-whited. The vapours from the drying chambers should be discharged at an elevation greater than that of adjoining houses.

The Manufacture of Blood or Blood-Clot into Manure. *Manufacture of Blood Manure.*

The conversion of blood or blood clot into a blood manure is effected by the use of an acid (which is almost invariably brown sulphuric acid), and subsequent drying. In only one instance have I seen hydrochloric acid used.

Processes as observed.

The process will be best understood by describing what I observed at two works in different places, in one of which fresh blood is used, and in the other blood-clot from an albumen factory.

1. At Cole's works, near Calne.

1. At Cole's blood-manure factory near Calne fresh blood is received from the large bacon factories in Calne. It arrives in a large cask laid upon its side on a framework upon wheels, and so arranged that the hindermost end can be tipped a little upwards. The cask contains about three hogsheads of blood. On the upper side is a circular opening about 8 inches diameter, having a rim and gutta-percha washer on which an iron plate or cover can be secured by means of screws. At the fore end is a discharge opening about 4 inches diameter, and a short pipe fitted with a slide valve. The blood is run in by the upper aperture. On arrival at the works the contents, which at my visit were still warm, are stirred through the same aperture with a stick, and then the slide valve of the discharge pipe being raised the contents are run out into a wooden tank, which they fill to about two thirds of its capacity. Brown sulphuric acid is then added and stirred with the blood until it coagulates to the consistence of thick mud. The tank being open this stirring is done by hand. The mixed material is then dug out and transferred to a bin roughly constructed of boards or wattles, which allow liquid matters to drain out and run over the floor of the works to sunken tanks provided for their reception. This liquid is used up in future operations. The material is then dried spontaneously. To allow of this there are erected outside the works, and at a height of about one foot from the ground, wooden floors on which the material is spread out. They are covered by a roofing which is capable of being moved from one part to another of the framework which supports it above the floor; and there are wooden sides attached by hinges to the floor below, by means of which the floor can be shut in all round, or at either end, as may be requisite to meet varying conditions of the weather. The material dries in about three or four days in summer, but takes longer to dry in the winter. When dry, it is sold off or mixed into a manure with other materials, such as scutch manure, the ashes of burned tan, or superphosphate made on the premises. The establishment is situated in a very isolated spot far away from any dwellings. Formerly, that is to say, until within the last six years, it was a very serious nuisance, complaints of which were made by persons residing as far off as a mile from the works, and by persons travelling along the high road. The cause of the nuisance was the drying of the mixed material by artificial heat upon a heated floor or kiln. When this was given up, and spontaneous drying substituted, the nuisance ceased.

Formerly a nuisance.

Mode of abatement of nuisance.

2. At King's works at Bristol.

2. At King's blood albumen works near Bristol, the blood-clot from the works is converted on the premises into manure. On these premises there is a building with louvred sides all round (formerly in use for glue-making), and the floor of this covers a part of the open yard. The clot is laid on the stones under the shed thus formed, brown sulphuric acid is added to it, and the whole mixed together by hand. At the time of my visit a large heap of the mixed material lay in this situation, where it is left to coagulate throughout and to drain, the acid bloody-looking liquid draining out passing across the yard to a drain inlet. After thus lying in a heap for about a month the several portions of clot have usually become sufficiently solidified throughout to permit of the material being dried. This drying is effected, sometimes by spreading it on a steam chest about 3 ft. square, and sometimes by spontaneous drying upon the floor of the covered building, or on racks or nets within the

building. The Medical Officer of Health tells me that serious complaints of nuisances from these works have been made. On Effluvium-Nuisances, by Dr. Ballard.

At Hyland's blood albumen factory at Belle Isle some of the clot is converted into a kind of manure by first comminuting it in a mill, and then by hand labour mixing with it powdered alum in small quantities at a time.

The mixing of blood with acid gives rise to a sickening vapour which under ordinary circumstances may be a source of nuisance. The drying process especially, if conducted by heat without due care and precaution, is also liable to create a nuisance. Effluvium-nuisances.

The mixing with acid should be conducted in a close vessel, the vapour from which should be conducted through a fire, and the drying, if effected by heat, should be carried out in the manner recommended below. Mode of prevention of nuisances.

Blood Drying and Blood Boiling.

Blood Drying and Blood Boiling.

The drying of blood-clot (the refuse of albumen makers) and of blood in a condition unfit for use by albumen makers, is now commonly effected upon a tiled floor heated by flues underneath, the floor being protected by a roof of some kind, or situated within a building. In a few instances, as for example at Walshe's factory at the Manchester abattoirs, the drying is effected by laying the clot upon a floor formed by a steam chest. By the latter method, however, the blood is dried more slowly than by the former. "Blood boiling" is a process now almost obsolete; it appears for the most part to have been replaced by albumen making and clot drying. Nevertheless I have seen it in operation in two or three places. It is conducted either by throwing free steam into the blood or by boiling the blood in a large pan furnished with a fire beneath. The steam boiling may be seen in operation at Hempleman's manure works at Stratford, and at Hale's small works near the South Bermondsey railway station. The blood is first mixed with water and, after boiling, the watery liquid is separated from the coagulated mass first by straining and subsequently by pressure. The coagulated residue is dried on a kiln heated by a fire beneath, or sold in the condition in which it leaves the press. The only place at which I have seen blood boiled in a pan by means of a fire beneath, has been at Forrest's albumen works near Paisley. The foreman told me that the blood was boiled until it was nearly dry. Processes as observed.

All these processes are necessarily offensive if the blood used be in any degree putrified, and if due precautions be not used to arrest and properly dispose of the offensive effluvia. The offensiveness is least when the blood or blood-clot is fresh and when steam is used for boiling and drying. It is apt to be very great, and the nuisance may be perceptible at a long distance from the works, when fire heat is used for boiling or for heating the drying floor. The offensiveness is then due in great measure to the partial charring of the blood, either in the pan or on the kiln, a result which it is nearly impossible to entirely provide against. For this reason all processes of boiling and drying ought, in populated localities, to be effected by steam heat, which is more readily regulated than fire heat, and the steam and vapours should be discharged at a sufficient elevation. Moreover, to provide against occasional nuisance in the event of putrid blood being dealt with, there should be means of condensing the vapours that arise, and conducting such as fail to be condensed through a fire. Effluvium-nuisances. Mode of preventing nuisances.

Gut-scraping, Gut-spinning, Preparation of Sausage Skins.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 4, 1875	Link - -	Whitechapel.	
„ 5 „	Tracey - -	Belle Isle.	
„ „ „	Edwards - -	Do.	
„ 23 „	Neville - -	Tottenham.	
Dec. 11 „	Potier - -	St. George's Southwark.	
„ „ „	Curtis - -	Do.	
Jan. 5, 1876	Ford - -	Railway arches, Rotherhithe.	
June 14 „	Garner - -	Clayton, Manchester.	
„ 15 „	Schlater - -	Salford.	
Aug. 16 „	Spencer - -	Cheltenham.	
Dec. 4 „	? - - -	Glasgow.	
Jan. 11, 1877	Poulton - -	Kingston, Portsmouth.	
„ 29 „	Day - -	Reading - -	Slaughtering, bacon curing.
„ 30 „	Thomas Harris -	Calne - -	Do.
Feb. 6 „	C. Harris - -	Do. - -	Do.
Mar. 15 „	Coulson - -	Cambridge -	Slaughtering.
„ 28 „	W. & C. Forrest -	Brediland, Paisley-	Blood boiling and albumen making.

Nature of the business.

"Gut-spinning" is the twisting of prepared gut into cord of various diameter for various purposes, *i.e.*, for ordinary catgut, for use in machinery, and for fiddle-strings. Hence in different establishments articles of different fineness and coarseness are prepared, from the most delicate fiddle-string to a thick catgut cable. Sometimes all these varieties are made in the same establishment. The first operation, however, in every instance is the "gut-scraping." For sausage skins the manipulation of the gut ceases here.

Material used.

The gut used for the above purposes is the small intestine of sheep and hogs. It is said that the sheep's small intestine measures 25 to 30 yards, and the hog's about 20 yards. The guts are collected from butchers, and in some establishments they are received from the country, or, packed with salt in barrels, from Ireland. In some establishments dried guts previously scraped are received from abroad for further manipulation. For fine purposes, such as the making of fiddle-strings, only the best and freshest guts from the butcher can be used, but for coarser purposes their condition as to freshness is less material, and sometimes they arrive at the works in an offensive condition. The scraping is more easily effected when the gut is not quite fresh.

Process.

The first operation in gut-scraping is to get rid of the contents of the gut. For this purpose it is thrown into a tub of water, by which a man sits, and passes the gut between his fingers into another tub of water, pressing the contents along the cavity as he proceeds. In some works water from a tap over which an end of the gut is slipped is run through the gut. This is repeated several times until the gut is quite clean. At Mr. T. Harris' at Calne, the guts are then placed in brine for eight or ten days, and then for three or four days in cold water.

Scraping.

The process of scraping is, in the larger establishments, performed by women. A bench or table is provided, at which a woman sits and

scrapes the gut with a wedge-shaped piece of wood as she passes it along the table before her. In some places I have seen the back of a knife used for this purpose. By this process all the interior softer parts are detached and pass along the gut to the end, where they are discharged, the peritoneum of the gut, and probably a little of the muscular layer, being alone left. It is again thrown into water.

The further treatment depends upon the use to which the scraped gut is to be applied. When it is to be used for sausage skins, the scraped guts are simply packed in barrels with salt. Such as are intended for making catgut or fiddle-strings are treated further.

In some establishments scraped guts are dried for exportation. They are stretched over frames, dried in a chamber artificially heated, and then tied up in bundles. When dried guts are received they are soaked in water to prepare them for spinning. Spinning.

For making ordinary catgut no further preparation is needed than sewing together lengths of scraped gut with a needle and thread. They then go to be spun by means of an ordinary spinning wheel. The number of strands of gut spun into a cord varies with the thickness of catgut required. Catgut of half an inch in thickness will have as many as 700 strands of gut in it. When a length of catgut has been spun, it is dried by stretching it over pegs and exposing it (protected in some way from the weather) in the open air. Before drying, however, it is customary to bleach it by stretching it upon a frame and putting it for about three days into a chamber where it is exposed to the action of the fumes of burning sulphur.

The preparation of fiddle strings is a very delicate operation, and, for the finest violin strings, requires the utmost care. The best scraped guts alone are used, and such as have any flaw in them are rejected. Each gut is treated separately. It is put into a clean earthenware pan containing a weak solution of carbonate of soda, and this solution is changed (a fresh pan being used each time) twice a day for seven or eight days, and, each time the gut is transferred, it is stripped through the ringed part of a strip of copper bent into the shape shown in the margin, the thumb being pressed upon the gut as it is passed through. After this treatment it is ready for spinning. The first strings of violins are made by twisting together three, or better four, such prepared guts.

Gut-scraping establishments vary very much in character. My first experience of the process of gut scraping was obtained many years ago in a dirty little room at the end of a little blind court of small houses at Belle Isle. This was a horrible little place, but I have since seen worse. For instance, when I was at Salford, Dr. Tatham, the Medical Officer of Health, took me to a place which had been much complained of. It was a small, low, dilapidated, wooden shed in a field, and close to an inhabited house and a roadway. The paving, such as there was, consisted of some loose stones, and in the centre was a kind of well or cesspit covered with some loose boards. Part of the drainage from the floor ran into this pit, which was the only water supply available, and part into a filthy little pond just outside the door. The immediate surroundings, where pigs and fowls were kept, were also indescribably filthy. Only sausage skins were prepared here. When I was at Bilston, the Health Officer showed me the late site of a similar workshop, the occupants of which had recently removed after proceedings under the Public Health Act. The work of sausage-skin making was carried on in a small washhouse Character of establishments.

On Effluvium-Nuisances, by Dr. Ballard.

in the yard at the rear of a pair of small houses in a side street. The yard was closely built in. Next the door of this washhouse was a filthy leaking cesspool privy. Happily all gut-scraping establishments are not like those which I have attempted to describe; but many of those devoted merely to the preparation of sausage skins, especially in large towns, are of this miserable character. Between this class of establishments, which are carried on by poor people, and the best kind of gut-spinning establishments, in which a fair amount of capital has been sunk, there are all grades.

Effluvium-nuisances.

Speaking generally of gut scraping and gut spinning establishments (I except a very few, such as those I shall mention presently), they are the most intolerable of nuisances wherever they may chance to be located. Within the workshops the stench is inconceivably horrible: few persons unaccustomed to it could bear to remain for a single minute in some scraping rooms that I have visited, and I myself have sometimes had a difficulty to restrain vomiting and to carry on the inquiries I was bent upon. The stench, after I have been in some of them for 20 minutes or half-an-hour, has so pertinaciously attached itself to my clothing and hair, that only repeated ablutions have removed the odour from my hair, and my clothing has retained the stench for days. It spreads from the workshop and yard all round the neighbourhood, and often gives rise to such loud complaints that local authorities in some towns have insisted upon entire removal out of them.

Effect upon health.

It would not be unreasonable to expect that where such putrid animal effluvia as proceed from gut-scraping establishments, pervade a neighbourhood, the public health in that neighbourhood would obviously suffer from them. But the several health officers I have questioned upon the subject have been unable to furnish me with any evidence, either that septic diseases prevailed more in such neighbourhoods than in other similarly peopled parts of their districts, or that there was more general sickness, or that zymotic diseases prevailed more, or were more fatal. It is quite possible (may I say probable?) that the opinion they gave me upon this point resulted from imperfect observation. But it is very certain that there is no trade among all those I have inquired into, which is more fruitful in inducing those minor and temporary disturbances of health which exposure to disgusting smells is apt to produce. There is no occasion for a person to be in any way delicate to predispose him to this result.

Sources of nuisance.

The sources from which nuisance arises in such works as these are too obvious, from the description which I have given of them, to require enumeration. I need only say that they may arise either from the premises themselves in which the work is carried on, or from deposits of refuse matters in inappropriate places or without due precautions being taken to arrest the offensive effluvia arising from them. I may, therefore, at once pass on to the mode in which I have, in some establishments, found these sources of nuisance more or less obviated.

Establishments described.

Perhaps the most satisfactory course will be to describe some of the larger works I have visited, commencing with one where the nuisance was very considerable, and then giving a description of some works where the nuisance has, I understand, been prevented.

Establishment in Whitechapel.

The first establishment I shall describe is situated in a narrow street of small houses in Whitechapel, and the entrance leads to a yard filthy and stinking. Water from the workshop was at the time of my visit lying in pools in the yard, and scrapings from the guts were littered

about it; and there was an untrapped pipe drain opening, by which the more liquid refuse might find its way into the public sewer. The building, entered from the yard, consists of a ground floor and an upper floor, the ground floor being devoted to the scraping department, and the upper floor to the spinning and preparation of fiddle-strings (a common arrangement in gut-spinning establishments). The ground floor room was most horribly offensive. It was partly paved and partly boarded, but both imperfectly, and was everywhere excessively filthy from refuse matters long trodden in. The tubs and plant in this part of the premises were as uncleansed as the premises themselves, and the work was being performed without any proper precautions or care not to spill or let fall refuse matter upon the floor. The upper floor was cleaner, and the part where the guts were being prepared for fiddle-strings presented, nothing objectionable beyond the all-prevading smell from the lower regions.

Tracey's establishment in Islington.

The next establishment I shall describe is that of Mr. Tracey, in Belle Isle, Islington. Here, again, there are two floors, the lower devoted to the scraping and the upper to the spinning and fiddle-string preparation. The buildings were erected for the purposes of this trade and all their arrangements have been directed accordingly. The yard was well paved, well drained, and clean, and the ground floor of the building was also well and evenly paved, clean, and free from litter. All that was required was some scraping and lime-whiting of the walls against which the scraping bench was situated. The offensiveness of this room was comparatively trifling: but little work was going on at the time of my visit. The upper floor was clean, tidy, and inoffensive. There was no nuisance observable outside the premises. It would not have been suspected by anyone that a gut-scraping establishment was there.

Garner's establishment at Clayton.

But the most perfect establishment, in its arrangements, which I have seen is that of Mr. Garner, at Clayton, Manchester. He formerly had works at Levensholme, from which place he was compelled to remove, it is said, on account of the nuisance they were to the neighbourhood. A great outcry was made when it became known that he was about to remove to Clayton, but, now that he is fully established there in his new works, the health officer tells me that no nuisance whatever is occasioned. He took me to the works with a view of showing them to me as model works of the kind. No work was proceeding on the day of my visit, but the arrangements of the workshops were clearly such as to conduce to salubrity and avoidance of nuisance. At these works all the workshops are upon the ground floor. The room devoted to the scraping is very well paved, capacious, and very clean, both as respects the walls, floor, and plant. Along the whole length of the shed, beneath the paving, there is a drain to carry off the liquid refuse of the shop; it is about a foot diameter and communicates, at the further end of the shop, directly with the ashpit of a boiler fire by means of an iron facing over the mouth of the ashpit. Hence all the air for the fire is derived from the drain. The drain openings in the shed are untrapped, and there is a good fall in the opposite direction to the fire towards the town sewers, between which and the workshop is interposed a manhole shaft, by which the drain can be arrived at outside the works, and cleared, if this should be at any time necessary. There is an unlimited supply of water from the neighbouring canal, so that a perpetual flow of water through the drain is provided for. Mr. Garner says he finds that, by this means, he can keep the atmosphere of the workshop comparatively sweet, air being drawn through it for the supply of the

On Effluvium-Nuisances, by Dr. Ballard.

boiler fire by the untrapped drain openings, while the drain is kept clear by a constant flow of water. The spinning and drying are conducted under a long shed glazed at the sides along the whole length of 50 yards with sliding sashes, like a greenhouse, which are open in the summer, but in winter and damp weather are closed, and then the shed is artificially warmed for the drying of the catgut by a steam warming pipe carried along both sides near the floor.

Use of deodorants.

In none of my visits to works of this character have I seen any deodorants applied to such raw gut as comes to establishments in an offensive condition, or to such as has been left to soak until offensive for the convenience of ready scraping, nor yet to the offensive refuse of the process, for the purpose of destroying their bad odour. But that the use of a chemical agent for the prevention of putrefaction in the fresh guts is practicable, and practised successively in some establishments in France, is shown by the following extract which I take from M. de Freycinet's report on Trade Sanitation,* the only work of the kind that I am acquainted with :—†

"Le nettoyage ou séparation de la membrane péritonéale dont une partie seulemente a été enlevée par le dégraissage á l'abattoir, s'exécute ordinairement à la suite d'une fermentation putride qui constitue un des détails les plus repoussants de cette industrie. Cette macération, dont la durée varie de huit jours à un mois selon la saison, a pour objet de décomposer en partie la muqueuse et de la rendre moins adhérente, afin que les ouvriers puissent la détacher sans risque de nuire à la qualité des boyaux. Quelques industriels commencent à adopter le procédé Labarraque, consistant à immerger les intestins dans une solution de chlorure de soude, ce qui dispense de toute fermentation putride. La fabrique de MM. Monnier et Dutripon, à Eysines (Gironde), remarquable d'ailleurs par l'ordre et la propreté qui y règnent, marche dans ces conditions depuis trois ans. Aujourd'hui quelques heures suffisent pour permettree d'effectuer le ratissage des boyaux."‡

The only place that I have visited in which an antiseptic solution is used is Mr. Coulson's sausage manufactory in Cambridge. Here it has been the habit for some time past, on the suggestion of Dr. Anningson, the Medical Officer of Health, to immerse the fresh guts for a few days before scraping them in a weak solution of chloralum. Mr. Coulson tells me that while this practice has eventuated in doing away with all nuisance, it has not injured the guts, nor rendered the scraping of them in any way more difficult.

Modes of preventing nuisances.

It follows from all that has preceded, that the essentials for carrying on this trade in a manner devoid of nuisance are:—1. A building

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* The title of the work is, "Rapport sur l'Assainissement des Fabriques ou des "procédés d'industries insalubres en France, Angleterre et dans la Belgique et la "Prusse Rhénane, par M. Charles de Freycinet. Publié par ordre de son Excellence "M. le Ministre de l'Agriculture, du Commerce et des Travaux publiques. Paris : "Dunod, 1866."

† I must, however, except Dr. Waller Lewis' "Report on the Laws and Ordon- "nances in force in France for the Regulation of Noxious Trades and Occupations." [Presented to both Houses of Parliament by command of Her Majesty.] 1855.

‡ M. de Freycinet adds—"Le conseil d'hygiène publique de la Gironde est telle- "ment convaincu de la supériorité de ce procédé, qu'il le rend maintenant obligatoire "Ainsi un arrêté du juin 1864, relatif à la boyauderie de Madame Veuve Chrétien, "porte la clause suivante : Art. 10. Lorsque les boyaux auront été degraissés et "retournés, on emploiera du chlorure de soude à 12 ou 13 degrés à dose de 1·500 "grammes dans deux ou trois seaux d'eau pour un tonneau renfermant les intestins "grêles de 50 bœufs."

speeially erected or carefully adapted to the peculiarities of the trade, sufficiently spaeious, and situated as far as praetieable in a loeality not closely built in. The ehamber where any of the more offensive parts of the trade are eonducted should have no direct eommunication with other rooms. It should be lighted either from the sides or roof with windows ineapable of being opened, and ventilation should be provided for independently. It appears to me that the best mode of managing this would be to arrange for the drawing off of the foul air of the chamber eontinuously, and conducting it through a fire, or first through a sereen of wood charcoal and then through a fire, and that the air for the supply of the room should be drawn from the outside through sereens, or properly arranged boxes, eontaining wood charcoal, duly protected from wet and damp, and from time to time renewed, whieh when the room was shut up at night would serve to arrest the passage outwards of offensive effluvia. The inner walls to the height of about 6 feet, should be covered with some impervious material capable of being washed, sueh as smooth eement or sheet zine. 2. The floor should be paved with an impervious paving, preferably jointless, and it should be properly sloped to a duly trapped drain gully. 3. There should be an unrestricted supply of water. 4. Serupulous cleanliness should be observed in the conduet of the business. The floor should be kept eonstantly sprinkled with some deodorant solution, sueh as of carbolic acid or chloride of lime; no unneeessary litter should be allowed, and any that may be made should be frequently swept up, and, together with refuse matters and serapings, should be deposited, with the addition of a deodorant, in appropriate vessels made of some impervious material, sueh as galvanized iron, and eovered with covers of like material when not required to be open for use. At the close of each day's work the floor and walls to the height of the impervious portion should be washed down with water containing some deodorant, and all tubs, tables, beneches, and utensils that have been in use should be similarly cleansed. The inner walls and ceilings should be periodieally lime-whited. 5. All undried gut brought upon the premises should be brought in closed impervious vessels, whieh should not be opened except in the chamber where they are to be manipulated, and all refuse matters should be removed from the premises daily in the closed vessels in which they are deposited. Any gut whieh arrives in an offensive condition should at onee be placed in a deodorant solution; and some antiseptic solution should (as appears to be practieable) be used for the soaking even of fresh guts on their first arrival. 6. Great care should be taken in dealing with the refuse matters after removal from the premises. If deposited anywhere upon land the matters should at once be eovered over with a layer of fresh earth. At Mr. T. Harris' at Calne, where the nuisanee from the deposit of refuse in his farm premises was at one time intolerable at a distance of several hundred yards, the nuisance has, without altering the position of the deposit, been obviated. A wall of straw litter is made, enclosing a space within which the refuse is thrown, and the offensive matter is immediately covered up with dry earth and ashes: this building up of the wall and deposit of refuse and earth is continued until a sufficient mound is raised. When it becomes necessary to remove this as manure, it is removed inoffensively. Sueh a stack as this should, however, be proteeted from the rain.

On Effluvium-Nuisances, by Dr. Ballard.

BONE-BOILING AND BONE-SIZE MAKING.

Establishments visited.

BONE BOILING AND BONE-SIZE MAKING.

ESTABLISHMENTS VISITED.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 5, 1875	Broach - -	Belle Isle.	
Dec. 11 „	Abel - -	St. George's Southwark.	Stuff-melting.
„ „ „	Hoare - -	Do.	Do.
Jan. 5, 1876	Torr - -	Deptford - -	Manufacture of animal charcoal and sulphate of ammonia.
„ 11 „	Gabriel Scott -	Nursling, Southampton.	Manufacture of artificial manure.
„ 21 „	G. Lockyer and Sons.	Bristol - -	Manufacture of animal charcoal and sulphate of ammonia.
„ „ „	H. & T. Proctor -	Bristol - -	Manufacture of artificial manure.
Feb. 23 „	Harris - -	Stratford - -	Fat-melting.
„ „ „	Scaborne - -	Do. - -	Do.
„ 24 „	Hunt - -	Bow Bridge -	Manufacture of artificial manure.
Mar. 20 „	Morris and Griffin	Wolverhampton -	(Steaming), manufacture of artificial manure, and sulphuric acid.
April 26 „	Walker - -	Nottingham.	
„ „ „	Hall - -	Do. - -	Potted meat making, size making.
May 13 „	Packard & Co. -	Bramford, Ipswich	(Steaming), manufacture of artificial manure.
„ 16 „	Vickers and Son -	Manchester -	Manufacture of size, soap, and manure, &c.
„ 17 „	S. Smith - -	Do. - -	Bone button making.
June 1 „	Phillips - -	Leeds - -	(Bone steaming), manure making.
Nov. 16 „	E. Cook - -	Bow Bridge -	Fat - melting, soap making.
Jan 10, 1877	? - - -	Near Portsmouth -	Pig-keeping.
Feb. 13 „	Proctor and Ryland.	Birmingham -	Manufacture of artificial manure.
Mar. 26 „	Burrell - -	Newcastle-on-Tyne	Do.
„ 28 „	J. Poynter and Son.	Greenock - -	(Steaming), manufacture of animal charcoal and sulphate of ammonia, manure making, &c.

Kinds of establishments where bones are boiled.

Butchers' bones, bones of horses and domestic cattle, and domestic refuse bones from the stores of what are called "marine store dealers," are boiled in several kinds of establishments with a double object, viz., 1st. For the extraction of the fat they contain ; 2nd. To prepare the bones for further trade applications. Hence we find bones boiled in establishments where nothing but bone-boiling is carried on, or where only the rendering of butchers' fat or kitchen stuff is conjoined with it; in soap works, manure works, knackeries, manufactories of bone buttons, &c., animal charcoal manufactories, dripping-makers' establishments, or establishments for size making, &c. In some of these places any bones are boiled indiscriminately ; in others

only bones of a selected kind are boiled. Equally varied is the extent to which the process is applied in different kinds of establishments. In bone-boiling establishments *par excellence* 20 or 30 tons are boiled in the course of a week. In some small establishments, where selected bones are boiled in preparation for some special future application of them, only a ton or two, perhaps, are boiled in the course of a week. Hence, too, it arises that the mode of boiling and the duration of the boiling differ in different establishments, and that in some a process of steaming under pressure is preferred to one of boiling, as on the whole more suitable.

Process.

Bones are not often boiled in the open air. The process is usually conducted under a shed or within a closed building. They are usually boiled in large iron pans or boilers, or tanks; sometimes quite open, at other times provided with a lid. Heat is applied either by a fire beneath the pan or by perforated steam pipes introduced to the bottom of the pan. The long bones of the larger animals which contain marrow are first sawn through, usually with a circular revolving saw, so as to separate the ends from the shank and to open the central cavity containing the marrow. Sometimes the shanks are split with a hatchet or sawn along their whole length. Shorter bones and flat bones are usually simply sawn across. When the boiling has been carried far enough, and all the fat is believed to be extracted, the fat is skimmed off.

Thus far the process is similar in all works where bones are boiled in boilers or tanks. But the duration of the boiling is not always the same. Where the object is merely to extract the fat from the bones and to prepare them for bone-manure making, a few hours' boiling suffices; but when there is in view the further object of making size from the bones, the boiling is, with occasional additions of water as it boils away, continued for four or five days and nights. The subsequent dealing with the boiled bones and liquor also varies with the object in view. Thus at the ordinary bone-boiling establishments it is customary to discharge the boiled bones into a brick chamber, which is termed the "bone-hole," where they lie, and in time become dry by a process of spontaneous heating. They remain there until the bone-hole is filled and requires emptying. The bone-hole is usually sufficiently capacious to hold a week or ten days' working, sometimes more. When bones are boiled at manure works or at soap works it is common to dry them in a chamber by the same process.

The best long bones are, after boiling, reserved for making bone buttons and bone handles of various kinds; and to preserve their white colour they are thrown into a tank of cold water as soon as they are taken from the boiling pans.

At ordinary bone-boiling establishments the residual liquor, although containing more or less gelatin, is run off into the drains. But in establishments where size is made, the gelatinous liquor, obtained by the prolonged boiling, is drawn off by a tap from the lower part of the boiler, and is subsequently boiled down to the requisite consistence, either in the same or another similar boiler, from which it is usually drawn off into casks for sale.

Effluvium-nuisances.

Bone-boiling, as ordinarily carried on in large bone-boiling establishments, is often a cause of considerable annoyance to the neighbours. In small establishments where fresh butchers' bones are used for making dripping, or where heads of oxen are used for making potted meat, and the bones are subsequently boiled for size making, the nuisance is at its minimum. But large establishments where several tons of bones are boiled daily for subsequent use in manure making, or to obtain fat for

the manufacture of soap, have over and over again been made the subject of complaints, and have required the interference of local authorities for their regulation and amendment. The disagreeable smell may extend for 100 yards or more around the works, according to the direction of the wind.

Sources of nuisance.

The sources of nuisances from bone-boiling establishments may be one or more of the following :—

1st. The reception and retention on the premises, especially in the open air, of stale or semi-putrid bones, such as are supplied from marine store dealers, who purchase them in driblets from private houses in London and other large towns, and themselves retain them until a sufficient bulk has accumulated to render it worth while to send them away.

2nd. The process of boiling. Where fresh bones from the butcher are boiled, the steam which issues has merely a brothy odour, which, although not nauseous, is sufficiently unpleasant, if pretty constant or if it is frequently blown by the wind into the windows of adjoining dwelling-houses. But when the bones are stale or putrid, a nauseous character is added to the smell, which may then travel with the wind to a considerable distance. This putridity of the bones and vapour is more likely to happen in the summer time than in the winter season, and it is in hot weather that such a smell as this is least readily tolerated. Similar steam is given off when the charge of boiled bones is removed hot from the boiler.

3rd. But the principal source of nuisance is ordinary bone-boiling is the effluvia from the bone-hole. When recently boiled bones are heaped together the heat from superficial decomposition, and large volumes of steam having a very offensive musty ammoniacal odour rise from them. This steam fills the bone-hole or chamber to such an extent that it stings the eyes and nostrils of a person entering it, when bones have been lying there for a week or longer. The vapour escapes from the roof, which is sometimes furnished with a skylight which is opened to permit its escape, or from louvres provided for the same purpose. This offensive effluvium travels farther, and is usually more seriously complained of than that from the mere process of boiling.

4th. I heard of one small establishment where bones are boiled for size, and subsequently thrown into cold water, which had in the summer time been made the subject of complaint by the neighbours, on the ground of the offensive smell issuing from a drain down which some liquid from the works had been cast. It was found that the source of the nuisance was the discharge into the drain of the cold water in which the bones had been soaked or cooled, and which had been allowed to stand until it had become putrid.

With the exception of the occasional production of the series of temporary functional disturbances referred to in the introductory part of this Report, such as nausea, loss of appetite, a sense of depression, and headache, I have not been able to discover that any serious effect upon health has been occasioned by exposure to the effluvia from bone-boiling establishments.

Modes of preventing nuisances.

As respects the mode of preventing or minimising the several nuisances which may arise from bone-boiling works :—

1st. The nuisance arising from the reception and storing of stale and semi-putrid bones may be obviated by their transmission and storage in tarred bags or other closed receptacles, and by their utilisation as speedily after reception as may be ; or if the bones are placed in a heap in the works, they may be in great measure prevented from being a nuisance by covering the heap with a tarpaulin.

2nd. The steam from the boilers is a nuisance very much according to the elevation at which it is discharged. When discharged at a considerable height it rapidly diffuses itself, and does not usually fall to the ground in a sufficiently dense form to create a nuisance. Hence, where practicable, one mode of preventing this nuisance is to boil in a closed boiler provided with a channel or flue to conduct the steam into a sufficiently tall chimney shaft. At many of the works I have visited the boiling, formerly effected by means of a fire under the pan, is now effected by means of free steam, and it is said that the alteration has resulted in a diminution of the nuisance. The best boiling arrangements I have seen are at Vickers' soap and manure works, at Miles Platting, Manchester. Messrs. Vickers are very earnest, and take an interest in endeavouring to carry on their offensive trade without creating nuisance. At these works they make bone size, so that the boiling of each charge is prolonged to four days and nights. The following description of their plant and arrangements may therefore be useful. The bones which they receive are principally from the butchers, marine store dealers, and horse slaughterers. The bones first undergo a rough crushing. The boilers consist of five square, covered, wrought-iron vessels, each capable of boiling about 12 tons of bones at one charge. They are arranged in a bank. Each boiler is provided at the top with an opening in the cover, about 3 ft. diameter, which opening during the boiling is closed by a door or cover. A sufficient quantity of water is added to the bones, and the boiling is effected by close steam. At the end of 15 hours' continuous simmering the fat, which by that time is extracted, is removed. The steam is shut off, sufficient water is added to bring the fat which floats on the surface to near the top of the boiler, and it is ladled out through the charging opening. This removal of fat is repeated after a further six hours' simmering, and then the boiling is commenced for the extraction of the gelatine. When the boiling is completely finished, that is to say, after three or four days and nights continuous boiling, the liquor is run out by a pipe and tap from the lower part of the boiler into another similar boiler at a lower level, heated in the same way, and here it is boiled down to the required consistence for size. It is then run off by a pipe into shallow iron vats, which are 8 or 10 inches deep, to cool and gelatinise. This size, it is said, is that used by dyers, and for stiffening calico goods. No alum is used, since it would render the size, it is said, unfit for the use to which it is to be applied. The charge of boiled bones, after running off the liquor from the first boiler, is drawn out by an opening in the side of the boiler, which during boiling is kept closely fastened up by a door fitting accurately and secured by some clamps. The steam from both the bone boilers and the size evaporating pan is carried off by a wide pipe fitted to the cover of each, and communicating with a flue which, after passing by the end of the flues from the steam boilers, conducts it, together with the highly heated gases from these flues into a chimney stack 210 feet high. The draught from this chimney is sufficiently great to cause a strong in-draught into the boilers whenever any of them are opened. The bones are drawn hot from the boiler, and are conveyed to a bone shed in another part of the premises. More or less disagreeable steam must be given off during this part of the process; but the sheds and buildings are very capacious and lofty, so that any steam diffused through them from this cause is well diluted before it reaches the outside atmosphere in the street. The steam from the actual process of boiling, however, is thoroughly disposed of. At these works about 80 tons of bones are boiled per week.

On Effluvium-Nuisances, by Dr. Ballard.

Description of Vicker's establishment at Manchester.

At Hunt's bone works, at Bow Bridge, the boiling is effected by free

Method at Hunt's works at Bow Bridge.

On Effluvium-Nuisances, by Dr. Ballard.

steam in long open tanks arranged in a lofty chamber, which is closed up, and the vapours discharged into it are drawn off (as also from the chamber where the boiled bones heat and dry and from all other parts of the works) by means of a powerful fan, and are passed together with the rest of the vapours, first, through a shower of water and then through a fire, on their way for final discharge by a tall chimney shaft. This, too, is very effectual, and moreover, obviates any nuisance from the discharge and drying of the boiled bones.

Passing vapours through a fire.

In small establishments where a fire under the pan is used, and no tall chimney is available, endeavours are often made to lessen the nuisance by covering the pan or boiler with a wooden cover, or close-fitting hood, having a portion in front hinged so that it can be raised for observation of the process, or for stirring the contents of the pan or removing fat. From the space between the boiler and the cover or hood, a flue conducts the steam into the ashpit of the fire beneath. The ashpit is provided with a close fitting door, so that all the air required by the fire must enter beneath the lid, pass over the surface of the contents of the pan and carry the steam with it through the fire to the chimney. This arrangement, which is similar to that described and figured as in use for fat melting (Fig. 4, p. 95), sometimes answers the required purpose pretty well, but the difficulty I have experienced with it in my own former health officer's district at Islington has been that of ensuring its proper use. Unless the master's eye is continually on his workmen, they are apt to leave the ashpit door open to improve the draught (as they fancy), or they allow the ashpit and the space in which the door moves to become choked up with ashes, or they take or break off the door altogether. Other dilapidations also readily occur and wholly destroy the efficiency of the apparatus. This arrangement is too much under the control of the workmen. Besides there is no provision against nuisance when the charge of boiled bones is removed. At Harris' establishment at Stratford, where free steam is used, the boilers are covered and the steam is drawn off by a fan to the boiler fires. As a remedy for the nuisances sometimes arising, although only temporarily, from the discharge of the hot boiled bones, it has occurred to me to suggest that in some cases the bones might be left to cool in the pan for a time before discharge, or that an extension of the practice (adopted in the case of the best shank bones) of throwing them into cold water might be practicable. But there may be practicable objections to both these suggestions.

Bone-steaming.

The practice of extracting the fat from bones by steaming instead of boiling them is adopted at some works. While this is applicable to the requirements of some establishments, as for instance, where the bones are required subsequently for manure making, it is clearly not applicable to all establishments where bones are now boiled, on account of the condition to which the bones are reduced. This method is in use at Morris and Griffin's works (superphosphate works), at Wolverhampton, and at Packard's superphosphate works, Bramford, Ipswich. At Morris and Griffin's the steamer (Plate 8) consists of a strong iron cylinder 6 feet long by 3 feet 6 inches in greatest width. The bones are introduced at the top and removed at the bottom by hinged doors, which are closely fixed down during the steaming. Superheated steam (about 286° Fahr.) is thrown in, and in the course of 40 minutes all the fat is extracted. The steam is then shut off, and the steam remaining in the boiler is let off into a condensing chamber. Half an hour later the fat is drawn off by a tap at the bottom of the cylinder. The door at the bottom of the cylinder is opened and the bones are allowed to fall upon the paved floor below. As the bones cool they are seen to be covered with a sort of varnish of gelatin.

They are much more brittle than bones boiled in the ordinary way, and are more easily ground. They are in a condition to grind immediately, so that the bone-hole or storing chamber is dispensed with. Several obvious advantages attach to this process. At these works the cylinder is capable of steaming at one charge 2 tons $6\frac{1}{4}$ cwt. of bones, which yield 87 or 88 lbs. of fat to the ton. This apparatus was the subject of a patent by Mr. Fuller, of Morris and Griffin's works (No. 893, March 29, 1865).

Method at Proctor and Ryland's works, Birmingham.

At Proctor and Ryland's manure works in Birmingham a strong iron cylinder is in use, in which the bones are first boiled with water by means of free steam thrown in for the extraction of the fat, and subsequently steamed for the extraction of gelatin. (Plate 9.) There are two such cylinders, each capable of boiling at one time six or seven tons of bones. At the upper end of the cylinder is a short neck surrounding the charging opening which is capable of being closed down with a close-fitting cover, and at this part the steam pipe which descends to the bottom of the cylinder enters, and the waste steam pipe passes out. At the lower part of the cylinder is a wooden false bottom to support the bones, and opposite to it on one side a man-hole (with close-fitting door) by which the boiled bones are finally removed. Entering at the side there is a pipe by which cold water can be thrown in from a cistern above ; and at the bottom there is a pipe for drawing off liquid matters. This pipe has two branches with appropriate taps; one branch leads to a drain and the other to a tank. The bones are first boiled with water by the agency of free steam ; when sufficiently boiled the steam is turned off and time is given for the fat to separate, and then cold water is thrown in below to raise the fat to the level of the charging opening, where it is run down a pipe into a receiving vessel below. The water is then run off into the drain, the top cover fastened down again, and the bones are steamed at a pressure of about 50 lbs. to the inch for extraction of gelatine. After some hours the gelatine is run off into a tank and the bones are drawn out by the man-hole near the bottom of the cylinder. All waste steam is passed off by a pipe above, which after a long course through the works (during which course some of the steam becomes condensed), dips some 18 inches into an underground tank of water—the same tank which will be described (p. 170), and figured (Plate 16), in describing the arrangements for manure making on the same premises. The gelatine is used for admixture with some kinds of manure. This arrangement obviates all nuisance from the actual boiling and steaming; but the bones subsequently removed to the bone shed heat and give off offensive vapour, although apparently not so much as bones boiled in the ordinary way. The bones are discharged in a friable condition, but not in so friable a condition as from Fuller's patent cylinder.

I have already described Mr. Dole's arrangement under the head of fat-melting (p. 92). The arrangements at Mr. Adams' knackery, in Birmingham, described and figured (Plate 6, p. 85) under the head of "Boiling of flesh, &c.," is well adapted to some kinds of bone boiling.

Modes of avoiding the "bone hole" nuisance.

3rd. In some smaller bone-boiling establishments I have seen attempts made to obviate the bone-hole nuisance by carrying a pipe from the upper part of the chamber into the chimney of the establishment; but as in none of these instances has the chimney been such as to cause a sufficient draught, all such attempts have been failures.

At Harris' works Stratford.

At Harris's establishment, at Stratford, the bone-hole is a close brick chamber from which at the roof there is a channel leading to a fan which draws air through the chamber, and sends it with the ammoniacal vapours through the boiler fire. This appears to have been fairly successful.

At Hunt's works Bow Bridge.

At Hunt's bone works, at Bow Bridge, where in former years the spontaneous heating of

On Effluvium-Nuisances, by Dr. Ballard.

At Broach's works, Belle Isle.

Use of artificial heat.

the boiled bones was a source of much nuisance, all nuisance is now obviated by the use of the fan and other arrangements already described, by which the vapours are drawn from the chamber and condensed by water or burned (*see* "Manure Making," p. 162). At Broach's establishment at Belle Isle an attempt was made, when I was medical officer of health in the district, to dispense with the bone-hole altogether, and to dry the boiled bones by artificial heat. The attempt has proved so successful that the method has been continued up to the present time. The drying chamber is closed with the exception of two openings, each about a foot square, in the wall at one end. It is provided with racks, upon which the bones as they come from the boilers are spread. There are coke fires placed on hearths near the middle of the chamber, but there is no chimney. This chamber will dry two tons of bones at one time, and the time occupied is 24 hours; three sacks of coke being consumed in the process. It is said that the temperature of the chamber can be raised to 160° or 200°. In the first part of the drying the openings in the wall are left free for steam to escape, but they are subsequently closed up. There is a make-shift, experimental character about this chamber which renders it open to improvement; but it is effectual in preventing nuisance. I know of no establishment where a similar method has been adopted.

4th. The remedy for any such source of nuisance as the fourth referred to, is too obvious to require mentioning.

The Manufacture of Animal Charcoal, &c.

Establishments visited.

The Manufacture of Animal Charcoal and also of Sulphate of Ammonia from Bones.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Jan. 5, 1876	Torr - -	Deptford -	Manufacture of sulphate of ammonia, bone boiling.
„ 21 „	G. Lockyer and Sons (two establishments).	Bristol -	Do.
Mar. 27, 1877	D. Arthur -	Greenock -	Knackery, manufacture of artificial manure, flesh and bone boiling.
„ 28 „	J. Poynter and Son.	„ -	Manufacture of sulphuric acid, sulphate of ammonia, and artificial manure, bone steaming, &c.
„ „ „	G. J. McFarlane -	Brediland, Paisley.	Manufacture of sulphate of ammonia and artificial manure.
May 14 „	T. Hadfield -	Pump - fields, Liverpool.	Manufacture of sulphate of ammonia.

So far as I have been able to ascertain, there are but few makers of animal charcoal in this country. The three largest makers are G. Torr at Deptford, G. Lockyer and Sons at Bristol, and J. Poynter and Son at Greenock, and there are one or two smaller makers; all but one of those whose works I have seen also manufacture sulphate of ammonia from the residual condensed liquors. At all these works, then, there are arrangements made, having for their object not only the production of bone charcoal, but also the condensation and utilisation of the bye-pro-

ducts more or less completely. On the Continent, as for example near Paris, I have seen bone charcoal made in a much rougher fashion, namely, by heating the bones in iron pots of due construction piled up in a furnace. Under this arrangement such of the volatalised matters as escape being burned pass off into the outer atmosphere by the furnace chimney. I have seen nothing of the kind in this country, although it is quite possible that this mode of manufacture may be practised somewhere. It cannot fail to be productive of considerable nuisance. On Effluvium-Nuisances, by Dr. Ballard.

The processes carried on at animal charcoal works in this country, then, include: 1. The boiling of the bones for the extraction of the fat, and sometimes also of some gelatine or size. 2. The distillation of the bones and their subsequent manipulation. 3. The condensation of the liquors and the utilisation of them. 4. The collection and utilisation of the gas produced; and 5. Sometimes the manufacture of an artificial manure. It will be convenient to consider the several processes in this order. Process.

1. Bone boiling, or bone steaming, which is sometimes substituted for the boiling, is conducted in one of the several modes already described under the head of "Bone boiling." But at animal charcoal works it is not requisite to dry the bones before distillation. The boiled or steamed bones are at once wheeled into the retort house for distillation.

2. The distillation of the bones is effected in iron retorts resembling very much those used in the distillation of coal for ordinary gas making. They are arranged horizontally in banks in a retort house, and are heated by fires beneath, the flames of which pass among them and raise them to a red heat. The open end of the retort projects a few inches beyond the line of the brickwork, and is fitted with an iron disc or cover, which, when the retort has been charged, is fastened and luted on. From the projecting end of the retort an iron pipe, about 3 inches diameter, conducts the vapours given off to the condensing apparatus. The distillation is continued for many hours, since it is essential that the bones shall be thoroughly charred. At some works an exhausting engine is in use to assist the carrying off of the vapours. When the bones are sufficiently burned the cover of the retort is removed, and the charge is drawn by raking out the charcoal into iron vessels (sometimes placed upon low wheels), each of a capacity sufficient to contain one charge. The charred bones nearest the opening not being fully burned are first removed, laid upon the heap of boiled bones, quenched with a little water, and subsequently returned to the retorts. The raking out occupies two or three minutes. An iron cover is then laid on the vessel, and luted round the edges so as to exclude the air. The whole is in this condition transferred to some place outside the retort house to become cold. When cold the charcoal is crushed to a coarse powder, the dust sifted out for the manufacture of manure, and the coarse part packed for sale to sugar refiners, &c.

3. The arrangements for condensation of the condensable part of the volatile products of the distillation resemble in principle, and also in the best works very much in detail also, those in use in gasworks for the condensation of the condensable products of the distillation of coal. Roughly, as two kinds of liquids, namely, tar and ammoniacal liquor, are condensed in the condensing apparatus in coal distillation, so in the distillation of bones two kinds of liquid are condensed, namely, bone-oil* and ammoniacal liquor. Perhaps the most lucid mode of

* Bone oil is an exceedingly complex substance of a peculiarly disagreeable odour. An elaborate investigation of it was made by Dr. Thomas Anderson who in 1848 published his results in the Transactions of the Royal Society of Edinburgh. According to this observer, a piece of fir wood, moistened with hydrochloric acid and

explaining the method of condensation will be first to describe that in use at the most perfect works (so far as the prevention of nuisance is concerned) that I have visited, namely, those of J. Poynter at Greenock, and then to point out some modifications I have observed at other works. Plate 10 is a plan of the apparatus in use at Mr. Poynter's works. The pipes ascending from the retorts to above the level of the bank bend downwards, and dip into a wide iron pipe running horizontally about a foot above the bank, and containing water. This corresponds to the hydraulic main in ordinary gasworks, and in it the first deposition of the condensable matter of the vapours takes place. The vapours next pass by the pipes A A to a continuous condenser B similar to that used in gasworks. It consists of a series of iron pipes arranged in pairs communicating (like syphon pipes) above and opening below into receivers or boxes, into which the condensed liquids fall, and where they collect. These pipes are freely exposed to the cooling operation of the external air. From the last of these pipes the gas, still containing condensable vapours, is conducted through two coke scrubbers C C or cylinders packed with coke, through which is made to trickle down from a box E above, either water or ammoniacal liquor pumped up to it from K which is a well of such liquor below. The well K receives ammoniacal liquor from the scrubbers, and the liquor is thus made to circulate through the scrubbers until it has attained the desired strength. The gas after being thus washed passes away by the pipe D to be further dealt with elsewhere. The liquors (bone-oil, and ammoniacal liquor) condensed in the continuous condenser are first received from it in a deep narrow square vessel F, where the first rough separation of the one from the other takes place, the bone-oil coming to the top end and the ammoniacal liquor sinking to the bottom. The liquids here are prevented from rising above a certain height by an arrangement for drawing off these two products separately. The oil is allowed to flow off at the surface by an inch pipe W to a tank or barrel V sunk in the ground, while the liquor runs away by a wider pipe G which is bent like a syphon and dips into the liquor below the oil, the top of the syphon being at the same level as the pipe which carries off the oil. This pipe conveys it into a receiver H. This ammoniacal liquor still contains a large quantity of oil, and to separate the latter more completely the liquor is next pumped through the pipe I into a subsiding vessel M (in this instance a long cylindrical boiler), having taps at one end, for drawing off the oil. The oil is from time to time drawn off into the oil tank V, and the liquor is pumped out by means of the pipe X which extends to the very bottom of the tank through the pipe L into the still N. But the oil in the tank V contains ammonia which it is worth while to recover. It is, therefore, pumped from V into another tank *a* placed above the receiver H, and steam is thrown in by the perforated pipe *b* so as to wash out the ammonia. The bottom of this tank falls in the centre, where the liquor deposited from the steaming collects, and where it may be drawn up by the pipe *c* either into a barrel *d* for conveyance to the still or into the receiver H. The position of the pump by which all the pumping is performed is shown at J.

At Torr's works at Deptford the arrangements for condensation are in most respects similar. There is a continuous condenser, but both before

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held over the mouth of a vessel containing it rapidly acquires the dark reddish-purple colour which is characteristic of the pyrrol of Runge. Acid agitated with the oil extract the bases it contains. Alkalies extract an acid oil and a considerable quantity of hydrocyanic acid.

the vapours enter it and also after leaving it they are passed through washers or tanks containing water. There is no coke scrubber. The condensed matters from these condensers, washers, and the hydraulic main are collected in an underground tank provided with a pump, where the separation of oil and liquor takes place, and from which, by raising or depressing the pump, tar or liquor can be separately pumped up at pleasure.

At G. Lockyer's works at St. Philip's Marsh, Bristol, there is no continuous condenser, but the vapours are condensed by passing them through a series of five washers or deep closed vessels containing water. In the interior of each of these vessels is a projecting shelf beneath which the vapours are introduced, and under which they have to travel in contact with the water to escape at the upper part of the retort, round the edge of the shelf, into the space above. In these tanks the oil collects above, while the ammoniacal matters are taken up by the water below, and each is run off separately at appropriate levels.

At Lockyer's works at Temple Back, Bristol, the arrangements for condensation are similar, but here the vapours only pass through four washers, and only two of these are shelved.

I propose to describe the utilisation of the oil and liquor presently.

At McFarlane's works, which are small works at Brediland near Paisley, the condensation arrangements are rough, and consist of a continuous condenser of salt-glazed ware, from which the vapours are passed into a small vessel containing water and sulphuric acid.

At D. Arthur's works near Greenock, also small works, other businesses are conjoined with that of the manufacture of bone-black, the principal of which are horse-slaughtering and manure making. There is no hydraulic main. The oil and liquor are condensed by passing the vapour through a worm condenser, and are then run into an open pan where horseflesh is boiled for manure.

4. The gas which remains after all condensable matters have been condensed is used either for lighting purposes, as at Torr's and Poynter's works, or for burning as fuel in the boiler fires, as at Lockyer's in St. Philip's Marsh, Bristol. In other works it is allowed to escape. When used for lighting purposes it is purified from carbonic acid by passing it through an ordinary gas lime purifier in its way to the gas-holder.

5. The utilisation of the char-dust and of the oil for the manufacture of an artificial manure will be described when the subject of artificial manure making is under consideration.

Manufacture of sulphate of ammonia.

The ordinary process.

The *manufacture of sulphate of ammonia* from the ammoniacal liquor is mostly effected as follows:—1. The liquor is run into an open tank lined with lead, and brown sulphuric acid is run into it in a small stream until it is saturated. During this process more or less bone oil, dissolved in the liquor, separates and forms a scum upon the surface, the liquor rises in temperature, and watery vapours smelling strongly of the oil is given off. 2. When saturated, the solution is transferred by pumping (if the tank be sunk), or by running off (if it be raised), into tanks or pans, where it is boiled down either by a fire beneath or by close steam. During this boiling large quantities of offensive steam arise, and in part condense as an oily matter upon the inside walls of the building, upon rafters, &c. The sulphate is scooped out with a perforated scoop and set aside to drain. It is of a brown colour and only fit for use in manure making.

Process at Poynter's works.

At Poynter's works at Greenock the method in use is far preferable to that which has been just described. The liquor which, under the scrubbing arrangement in use, is strongly charged with ammonia, is introduced into a still N and distilled by steam introduced by the pipe P,

and the vapours are conducted through O into a lead-lined pan, or tank Q containing water mixed with sulphuric acid, which is supplied out of an acid tank R from time to time as may be requisite to maintain constant excess of acid. As the liquor in the pan becomes supersaturated with sulphate, the salt which is then deposited at the bottom is taken out with a perforated scoop and laid aside upon the tray T to drain; the mother liquor draining from the salt runs into the tubs U and U, from which it is returned to the saturator. It is less coloured than any sulphate I have seen made in works where the ordinary process is followed. The vapours given off in the process of saturation are also less offensive at these works than at the other works I have seen, and are not allowed to escape into the building. The saturator is provided with a wooden cover having a sliding door which can be opened for purposes of manipulation, and from the space between the cover and the pan a pipe S conveys the vapours to a chimney shaft, the pull from which causes a current of air to pass in at the door and crevices of the cover and over the surface of the liquor.

Disposal of the bone oil.

The *bone oil* is variously dealt with. At some works it is put into casks and taken away by persons who purchase it; or it is burned as fuel, or mixed up with other matters in the manufacture of artificial manure upon the premises. At Poynter's works a part of the oil is used for manure making, but the greater part is pumped into an elevated tank *a*, from which a small pipe *e* conducts it, as it is wanted, to the boiler fire, into which it is blown as a spray by means of a jet of steam conducted by the pipe *f* to *g* where it issues at right angles to the opening of the pipe, at the furnace mouth. This arrangement for burning the oil and thus economising fuel apparently answers its purpose very well.

Effluvium-nuisances.

The effluvium nuisances arising from animal charcoal works depend mainly upon the escape of the vapours of bone oil and ammonia, but partly upon the associated processes, such as bone boiling and manure making. The odour of the bone oil and ammoniacal vapour is distinctive and very offensive. It will travel under favouring circumstances to long distances: the inspector of nuisances at Bristol tells that the nuisance from the works in that neighbourhood is sometimes perceptible at a distance of one or even two miles from the works. I have myself been strongly impressed with the odour at a distance of a full half mile. Beyond the ordinary functional disturbances occasioned by the impression made upon the senses by the offensiveness of the effluvia, I have not, however, been able to discover that the effluvia have proved injurious to the health of those exposed to them.

Sources of nuisances.

Omitting further allusion here to the nuisances dependant upon the process of bone boiling, manure making, &c., all of which will be considered in their proper places, and restricting myself to those which arise from the processes of distillation and the making of sulphate of ammonia, the following may be mentioned as the ordinary sources of effluvium nuisances from such works as these:—

An escape or leakage of offensive vapours from the retorts and condensors may occur when the covering of the mouths of the retorts is from any cause imperfect, or when there are dilapidations of the condensing plant of a nature to permit escape. Where a large number of retorts are connected with one hydraulic main and condensing arrangement, and especially if the gas has to overcome water pressure in the course of the condensation, such leakage is more likely to occur than under the opposite circumstances, if the passage of the gas from the retorts be not assisted by the use of an exhausting engine.

2. The drawing of the charge. As soon as the retort mouth is opened, and while the charge is being drawn, a gush of partly ignited vapour arises into the retort house, and escapes from the openings at the roof into the air outside.
3. The escape of pungent ammoniacal vapours from beneath the edges of the covers of the coolers up to the time when they may be effectually luted down.
4. The escape into the external atmosphere of the gas not fully purified from its condensable constituents. This is most likely to occur in works where the gas is not collected and utilized.
5. The evolution of bone oil vapour mixed with watery vapour during the process of saturation of the ammoniacal liquor with acid, and during the process of boiling down in the manufacture of sulphate of ammonia.
6. Leakages about apparatus provided with the object of disposing of such last-named vapours.

Nothing, but the exercise of great care, especially in details, will prevent such works as these being a nuisance. Nevertheless, I am satisfied that the nuisances are such as may be easily reduced to a minimum, or prevented altogether; and it is to the interest of the manufacturer thus to reduce them, since they represent a loss to him commensurate with the annoyance to his neighbours.

Modes of preventing nuisances.

1. It is most important that the provision for condensation shall not be in defect of what ought to be provided for the number of retorts in use at any one time. Where, from the mode of condensation used or from any other cause, the flow of vapour is likely to be retarded, or not to be sufficiently free, an exhausting or air pump arrangement should be added to the apparatus. Of course it is essential that the lutings shall be effectual, and that the plant shall be generally in such a condition as to avoid leakages.

2. I have seen nowhere any means in use to prevent or lessen nuisance from the escape of vapour during the drawing of the charge. Mr. John Thomson, now the manager of the Sankey sugar works at Earlestown, in Lancashire, informs me, however, that when he was connected with some works of this kind in Calcutta some years ago, he devised, and had for many years in use there, an apparatus which greatly expediated the process of emptying the retorts; and in this way he was enabled to reduce the amount of vapour given off. This consisted of a plate of iron one quarter of an inch thick, shaped so as to slip easily into the retort, and fitted with a long iron handle. The lower edge of the iron disc was made to fit the bottom of the retort, so that in pulling it out it would scrape everything before it, but in other parts of its circumference it was not made to fit the retort accurately. The handle consisted of a strong iron rod, made especially strong at the further end where it was turned up and rivited along the whole diameter of the face of the disc. It was sufficiently long to reach from the disc. When pushed up to the end of the retort, to the back of the retort door. Here it was provided with an eye. The rod or handle was thus made to lie within and along the whole length of the bottom of the retort. Before charging the retort, the disc was pushed in until it was brought quite to the further end; the retort was then charged, shut up, and fired in the usual way. The charge was drawn thus: immediately the door of the retort was opened, the workman passed a hook at the end of a long handle through the eye of the rod, and, with the assistance of another workman, drew forward the disc which scraped out before it the whole contents of the retort into the iron box provided to receive them. This was the work of only a few seconds; the retort door was instantly replaced, and a little soft clay was swept round the margin as luting.

3. There should be no delay, as soon as a cooler is filled, in luting down the cover. The ordinary practice is to put on the cover at once, and then to wheel the cooler to the outside of the retort house before the cover is luted down; and I have seen a row of such coolers left to stand outside for some time until it was convenient to the workmen to lute them all down consecutively. I see no good reason why the luting should not be done in the retort house immediately the cover is fixed in its place.

4. The gas should never be allowed to escape into the atmosphere. It should be collected in a gas holder, and utilized in some way.

5. Owing to the ready condensability both of watery ammoniacal vapour and bone oil vapour, and the combustibility of the latter, there can be no difficulty in preventing the nuisance that arises in the ordinary process of saturation and boiling down. The tanks or pans might be covered with an iron hood or cover capable of being partially raised or opened when requisite, from which a pipe might lead to a worm condenser or other cooling apparatus, terminating in a close box or receiver, from which another pipe should lead to a furnace fire, where the uncondensed vapours may be consumed. But the first essential of nuisance prevention is the previous thorough separation of the oil from the liquor in the earlier stages of the work. The more free the liquor be from admixture with oil, the less will be the nuisance, whatever method of making sulphate may be adopted; and too much pains cannot be bestowed in effecting the separation perfectly. To the fact of such pains being taken at Poynter's works must be attributed, I think, much of his success in preventing nuisance from this part of his work. But in other respects his process is far preferable to the ordinary one, although it might be improved, as it appears to me, by the substitution for his saturation pan of the curtained saturator, now largely used in works where gas liquor is used as the source of the ammonia, and by condensing the vapours that issue, conducting such as are not condensable through a fire, where they would be burned up.

6. It is scarcely necessary to say that leakage from dilapidations of the plant, and in the flues and conduits for vapours ought not to be permitted.

The Re-burning (Revivification) of Animal Charcoal.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Nov. 3, 1875	J. F. Brinjes - -	Whitechapel.	
Dec. 18 „	British and Irish Sugar Works.	Plymouth -	Sugar refining.
Jan. 12, 1876	Hills, Garton, & Co. -	Southampton -	Manufacture of "Saccharum."
„ 26 „	Wolff - - -	Bristol -	Sugar refining.
„ „ „	Old Market Sugar-house.	Do. -	Do.
„ 27 „	Finzel - - -	Do. -	Do.
Feb. 17 „	The Sankey Sugar Co. -	Earlstown, Lancashire.	Do.
Mar. 26, 1877	Blair & Co. - -	Greenock -	Do.
„ „ „	Alex. Scott and Sons -	Do. -	Do.
April 17 „	James Duncan - -	Victoria Docks	Do.
May 14 „	Macfie and Sons -	Liverpool -	Do.

Animal charcoal used in sugar refining.

The most important of the uses to which bone charcoal is applied in the manufacturing arts is its use for the decolourisation of syrup in sugar refineries. At these establishments a filtered solution of raw sugar is passed through large vats or cylinders (kept warm by appropriate means) containing bone charcoal in the crushed state described in the last section. In passing through the charcoal the syrup parts with colouring matters and some other matters also, such as gummy and albuminous substances, saline matters, especially calcic salts, and probably also some acid matters, organic and inorganic, as well as some of the sugar itself, which matters are retained by the char. Of these matters the char can only take up a limited quantity, so that while the earlier portions of syrup run through pass out absolutely colourless, the subsequent portions pass out more or less coloured, the colouration increasing gradually until the time arrives when the manufacturer finds that the charcoal has ceased to purify the syrup sufficiently for any of his purposes. This time usually arrives after about two days continued use, at some works even within a much shorter time. But it has been found that the purifying properties of the char may be restored by reburning it. It is this process of reburning or revivification which I am now about to describe.

Process. Preliminary washing.

Before the char is reburned it is necessary to wash it thoroughly to recover from it as much as possible of the sugar it has retained. With this object hot water is run through it, as it lies in the charcoal cistern, this washing being continued so long as sugar is recoverable in sufficient quantity to be of value to the manufacturer. The sweet water thus obtained contains not only sugar but also some of the organic and saline impurities which had been removed from the syrup. The water is drained away, and the char is then ready to be taken out and reburned. After draining, however, it still contains about 20 to 25 per cent. of water, and is quite damp to the hand.

The practice of washing the char, after its removal from the cylinders, with hydrochloric acid, with the object of taking out lime, appears, so far as I have been able to learn, to be rarely adopted in this country. But when the washing with hot water is performed too slowly the weak saccharine solution which results is apt to acetify, and this produces a similar result, which is recognised by the solution being opaque when it is run off. I am informed that this acetification is more likely to occur when the char has been in use for too long a time, and in old more readily than in new char. New char will often give off liquors smelling of sulphuretted hydrogen when the sugar refined is acid. Acetification will also occur under conditions of a sugar refinery which are little understood, but over which the managers are said to have no power of control. Also when imperfectly washed char, which after draining may still retain sweet water, is allowed to stand for some indefinite time before being reburned (not being reburned quickly after washing), it is apt to ferment and acetify. This fermentation is regarded as a benefit to the char, serving to open the char by removing matters within its pores which mere washing will not remove. It is mentioned in works upon the subject as one of the processes of revivification, and is said to be practised in some British factories. Sometimes the char is sent away from the premises to be reburned elsewhere; but in nearly all instances it is reburned upon the refining premises, a part of which is devoted to this process.

At all the works that I have visited I have found in use one of the two kinds of reburning apparatus that I am about to describe, or some

modification of them ; the modifications, however, not being, for the most part, of a character to affect the subject matter of this report.

Reburners.

1. Ordinary pipe kiln.

1. The pipe or tubular kiln or reburner. Messrs. McLean and Angus, engineers of Greenock, have been good enough to furnish me with a drawing of the ordinary form of this apparatus (Plate 11) which will assist me in describing it. Each reburner consists of a series of 64 iron pipes of the shape shown in the drawing, arranged in two banks or groups of 32 each on either side of a central fire, the whole being raised upon iron columns which being hollow are made to serve as flues. The flame from the fire plays among these pipes, and its direction, &c. are regulated by appropriate dampers. In the brickwork enclosing the pipes there is opposite each group an iron plate A, with an arrangement for viewing the state of ignition of the several rows of pipes. Beneath each of the six rows into which the pipes are distributed is a narrow iron box freely exposed to the air, and serving as a cooler for the reburned char. A slide valve at B permits the discharge into the cooler of the lower portion of the contents of the pipes from time to time, the coolers being emptied below upon the floor, or into appropriate vessels run in below them. The top of the kiln where the open ends of the pipes appear as shown in the drawing, forms a stage or platform near the roof of the building or shed where the apparatus stands. Upon this platform the damp char is placed and heaped up, and there it undergoes some preliminary drying by evaporation. Whenever a cooler is refilled the char sinks commensurately in the pipes corresponding to it, and a workman upon the platform at once with a shovel refills the pipes to the top. Whatever vapours are evolved from the reburning escape from the top of the char pipes and pass out of the building through openings in the roof.

Buchanan's reburner.

Buchanan's reburner is a modification of the tubular reburner which, while it is said to burn the char more equably, provides for the collection of the vapours that are given off. Plate 12 shows those parts of the apparatus which it is necessary here to describe. The tubes A are arranged much in the same way as in the ordinary reburner. Each pipe, however, is double, consisting of a wide external tube *a*, and a narrower internal tube *b*, and the char, falling from a stage or platform *g* above, occupies the space *c* between the two tubes. The internal tube is provided with openings *d* in its circumference at definite intervals, and these openings are protected from the ingress of char by a louvre-like projecting plate, inclined downwards at an angle, from the part of the tube immediately above them. The vapours given off during the reburning pass through these openings into the interior of the tube *b* which above opens, together with other tubes in the same row, into a horizontal channel or flue *e* which conducts the vapours away. The outer tube is made to revolve in its longitudinal axis around the inner one. There is also a modification of the cooler *f* below, which need not be here described.

2. Revolving cylinders. Brinjes' reburner.

2. Revolving cylinders, of which perhaps the best is Brinjes' patent reburner. Mr. Brinjes has kindly furnished me with a drawing of this apparatus (Plate 13) and with the following description of it. "Fig. 1 " represents a front elevation of the apparatus complete ; fig. 2 is a " sectional elevation of the same ; fig. 3 is a back elevation, and fig. 4 " a sectional plan thereof. A is the brick setting of the horizontal " retorts, B and C, each of which receives a circular reciprocating " or alternating motion of nearly one entire revolution on its longi- " tudinal axis. The upper retort acts as a drying chamber for preparing

" the charcoal for the recarbonization which takes place in the lower " retort; and it is contained in a separate brick chamber of its own, " which is situated immediately above the roof of the furnace or fire " place D, the heat from which, after circulating round the lower " retort, enters the upper chambers through openings left for that " purpose in the roof of the furnace, and then acts upon the upper " retort before passing off to the chimney. E E are passages provided " with dampers and leading to the main flue F below. The two " retorts are provided with a series of internal flanges, *a a*, at intervals " of about 6 or 8 inches, and ledges are formed between the flanges for " carrying up the charcoal as the retorts reciprocate. An opening is " made through each flange and all these openings are disposed in a " line with each other. In order to cause the charcoal to travel con- " tinuously along the retorts during the process of recarbonizing, an " angled projection, somewhat after the form of a three-sided pyramid, *b*, " is cast inside the cylinder in each of the intervals or spaces between " the several internal rings or flanges, and exactly in the centre line " of the openings in those flanges. The two opposite sides of these " projections present reverse angles, both of which direct the charcoal " into the next interval or space on the partial rotation of the retort; " the upper retort is driven direct by a mangle-wheel and pinion " arrangement, G, or other mechanical equivalent; and this motion is " transmitted to the lower retort by means of the endless chain, H, " suspended from the rear end of the upper retort and passing under the " corresponding end of the lower retort. Both ends of the retorts are " supported upon anti-friction pulleys, *c c*, carried in the transverse " framing I, bolted to the main supporting column K K. The feeding " hopper L opens to a flue M, from which the charcoal is shovelled " when being supplied to the retorts, the feed being nicely adjusted by " means of the sliding door *d*, worked by a winch handle and screw " spindle. N is a sliding door, covering an opening in the inclined " side of the hopper for the purpose of inspecting the interior of the " retort; a spy-hole being also provided at O in the stationary front " cover P, of the lower retort, for the same purpose. The upper " retort discharges its contents into the conduit Q, which conducts it " to the lower retort, after traversing which it is discharged down the " pipe R into the closed box or receiver S. From this receiver it passes " through the cooler, which consists of a number of long narrow " passages, T, placed side by side, and having intervening air spaces " between them for the more effectual cooling of the same. By the " time the charcoal has traversed these coolers it is sufficiently cool to " be exposed to the action of the atmosphere and is discharged into a " small truck or waggon, U. The vapours which are evolved during " the reburning of the charcoal are carried off by the pipe V, provided " with a throttle valve W, into the chamber X, communicating with " the chimney. The entire arrangement is supported upon strong iron " girders Y, resting upon column Z, in the basement."

When the reburned char is cold it is sifted, the dust is sent away to the manure makers, or used by the refiner in his "blow-up" pans where the raw sugar is dissolved, while the sifted char is returned, with so much fresh char as is requisite to make up for loss by sifting to the charcoal purifiers.

Effluvium-nuisances.

Under the most favorable circumstances the vapour that issues from char in process of reburning has an odour, usually sweetish and slightly empyreumatic. I have never observed the odour to be of a character that deserved the term "overpowering" being applied to it, but it is

sometimes sufficiently pronounced to be very disagreeable. In the "Times" newspaper of June 15, 1857, I find an account of a trial in the Court of Queen's Bench, upon indictment of Fairrie and others for a nuisance arising out of the reburning of animal charcoal at an establishment in Whitechapel. The indictment was successfully sustained after a trial that lasted three days. At these works it would appear from the evidence, as published, that the pipe-kiln was in use, and several witnesses from the neighbourhood deposed that they were greatly annoyed by the offensive vapours, some of them designating the odour as "disgusting," and stating that their health was injured by them, headache, sickness, vomiting, and difficulty of breathing being the symptoms specially mentioned. The late Dr. R. D. Thomson, a distinguished chemist, and at that time one of the Medical Officers of Health in the metropolis, stated that he had found by experiment that the gases and vapours given off consisted of carbonic oxide, carbonic acid, various hydrocarbons, and sulphide of ammonium, acetate of ammonia, and carbonate of ammonia, and Mr. Redwood, the Professor of Chemistry at the Pharmaceutical Society, confirmed him in all these respects.

Sources of nuisance.

At the time of this occurrence (or up to about 15 or 20 years ago), blood (just as it came from the slaughter-house) was, I am informed, universally used by sugar refiners in their blow-up pans, a pailful being usually added to the contents of each pan. Now, however, it is said to be rarely used, or, if any form of albumen is used, it is one of the inferior dark coloured kinds of blood albumen the preparation of which has been described at p. 106. When the solution of raw sugar after this admixture was filtered, the fibrin of the blood and the greater part of the albumen would of course remain within the filtered bags, forming thus one element of the "sugar scum;" but some might, and probably would, pass through, and certainly the filtered solution would contain the non-coagulable animal principles of the serosity; and these would be retained in the char when the syrup was filtered through it, giving rise to very offensive vapours on the char being reburned. The same thing must happen even now when blood or blood albumen are used. When the used char is permitted to ferment, the acetic acid formed acts upon the sulphides of calcium and iron present, eliminating sulphuretted hydrogen, the odour of which is perceptible, and which is given off when the char is reburned. Indeed it has, I am told, now and then happened that the quantity of sulphuretted hydrogen given off has been sufficient to cause an explosion on a lighted candle being accidently brought near the top of the cistern, when the door at the top of it has been opened. New char also contains sulphide of ammonium, and this is given off during reburning.

Modes of preventing nuisance.

That the nuisance from reburning is capable of being reduced by due care to a minimum is shown by the fact that, even in the case of Fairrie just alluded to, it was so reduced a few days before the trial commenced. Dr. Olding gave evidence to the effect that on June 2 he made experiments at the works, that at that time there was only a slight smell issuing from the tubes, and that the vapour given off did not contain either sulphide of ammonium or carbonate of ammonia; and the late Mr. Brande, of the Royal Institution, who experimented at the works on June 5, gave similar evidence. And I myself, unexpectedly visiting works where tube kilns have been in full operation, have often found very little offensiveness in the issuing vapours, certainly no more than might well, when diluted by the external air, be tolerated by the residents of any neighbourhood, however sensitive. Even at Macfie's Batchelor Street Works in Liverpool, at which blood is used, the vapours

proceeding from the ordinary pipe-kilns were not at the time of my visit exceptionally disagreeable or productive of nuisance; but at these works very great care is taken in the thorough washing of the char. I have never perceived any ill odours proceeding from works where Brinjes' patent reburner was alone in use.

Whatever ill odours may attach to the vapours must depend upon the evolution of sulphuretted hydrogen and sulphides, and the products of decomposition of the organic matters, hydrocarbonaceous and nitrogenous, taken out of the raw sugar in its passage through the charcoal purifiers. The remedies for the nuisance, then, are obvious, and they consist:

1. In the thorough washing of the char before reburning, so as to remove from it as much as it is possible to remove of those matters, which by their burning gives rise to offensive effluvia. At Duncan's works mechanical means are in use to hasten the passage of the syrup through the char, and the washings, similarly hastened, are continued for six or seven hours after the last of the sweet water has been removed. The time that elapses from charging a charcoal cistern to the char again going to the reburner is not more than 35 hours. Fermentation is thus, as I am informed, altogether prevented.

2. Means should be adopted for collecting and disposing inoffensively of the vapours proceeding from the reburning. When Brinjes' reburner is in use, the vapours are collected as a matter of course, and at the Whitechapel works alluded to above (which have since the date of the trial passed into the hands of Mr. Brinjes), the old pipe kilns have been replaced by his cylinders, and no nuisance whatever is occasioned. At these works the vapours are conducted first into a long brick chamber or flue 3 feet square internally, and thence into a chimney shaft at a point below that at which the furnace flue enters; this shaft discharges them at a sufficient elevation to prevent any nuisance, and at other works that I have visited I have seen the vapours discharged at once into a tall chimney shaft without occasioning nuisance. Should it be thought necessary, a means of condensation might readily be added to this apparatus. There may be some difficulty in collecting the vapours proceeding from pipe kilns, but it is nevertheless practicable. Dr. Odling stated at Fairrie's trial that the collection had been effected by drawing off the vapours accumulating beneath the roof above the kilns by means of a fan which drove them into the chimney shaft. At Duncan's sugar works a space above each stack of pipe kilns is boxed in with a wooden cover: hot air is conducted into this space from the fire by means of an appropriate flue at one end and passes out at the other end, carrying the vapours with it into a chimney. This arrangement is shown in Plate 14. At one part of these works there is a common horizontal flue to receive all the vapours from a row of reburners, and should it be requisite the vapours might very readily be condensed; after condensation of all that is condensable the remainder might be passed through a fire. One of the advantages of Buchanan's reburner is that provision is made for the collection of the vapours.

I lay some stress upon an arrangement having this object in view being generally adopted, because notwithstanding all the care a manager may take, he is still to a considerable degree in the hands of his workmen.

Establishments visited.

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
1873 (During a special inquiry on the banks of the Thames.)	Jas. Gibbs & Co.	Victoria Docks, West Ham.	Manufacture of sulphuric acid.
„	Odam	Do.	Do.
„	Thos. Farmer & Co.	Do.	Do.
„	Shroeder & Co.	Do.	(Dissolve guano), manufae- of sulphuric acid.
„	Moekford & Co.	East Greenwieh.	
„	Lawes & Co.	Barking Creek	Manufaeture of sulphuric aeid.
„	F. C. Hills	East Greenwieh	Manufaeture of sulphuric aeid, sulphate of ammonia, &e.
„	Bevington	Erith Marshes	(Seutch manure), extraction of fat from seuteh.
„	Brown	Do.	(Seuteh manure), extraction of fat from seuteh, glue making.
„	Miller & Johnson	Rainham Ferry, Essex.	Manufaeture of sulphurie aeid.
„	Wilson	Do.	Do.
„	Borell & Hagan	Do.	(Seutch manure).
1874	Bradburn	Wednesfield	Sulphuric aeid.
	H. J. Salmon	Britannia Works, Bermondsey.	Dealer in spent hops, rape eake, shoddy, woollen rags, and wool waste.
Nov. 9, 1875	Arnott Bros. & Co.	Millwall.	
„ „ „	Gould & Co.	Do.	Manufaeture of sulphurie aeid.
„ „ „	Purser & Co.	Do.	Do.
„ 22 „	Newton	South Bermondsey.	
„ 29 „	Town Manure Co.	Bilston	(Poudrette from night soil).
Dec. 17 „	Burnard, Laek, & Alger.	Plymouth	Manufacture of sulphuric aeid.
„ 16 „	Norrington	Do.	Do.
„ 17 „	Jas. Gibbs & Co.	Do.	
„ 22 „	Western Counties Manure Works.	Tor Point, opposite Devonport.	Manufaeture of sulphurie aeid.
Jan. 1, 1876	Ball & Davis	Huuslet, Leeds	Glue making.
„ 5 „	G. Hallett & Co.	Rotherhithe	Refining of antimony.
„ „ „	Hale	South Bermondsey	Blood boiling, dealer in seuteh and shoddy.
„ „ „	Two small works	Under railway arehes, Rotherhithe.	(Manure made from blood, fish, sawdust, &c.)
„ 6 „	Moekford & Co.	Ordnance Works, East Greenwieh.	(*Second visit.*)
„ „ „	F. C. Hills	East Greenwieh.	(*Second visit.*)
„ 11 „	Dixon & Cardus	Northam, Southampton.	Bone boiling, oil boiling.
„ 12 „	A. W. Hall & Co.	Redbridge, Southampton.	Manufaeture of sulphurie acid.
„ „ „	Gabriel Seott	Nursling, Southampton.	Bone boiling.
„ „ „	Spooner & Bailey	Eling, Southampton.	Manufacture of sulphurie aeid.
„ 20 „	Netham Chemieal Works.	Bristol	Manufacture of sulphuric acid and of alkali and bleaching powder.
„ „ „	Norrington Hingstone, & Co.	Do.	

ESTABLISHMENTS VISITED—*cont.*

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Jan. 21, 1876	H. & T. Proctor -	Bristol - -	Bone boiling.
„ „ „	Cottrell - -	Do. - -	(Scutch manure), fat melting, &c.
„ „ „	Kent - -	Do.	
„ „ „	Prangley & Co. -	Do. - -	Knackery, boiling of flesh.
„ „ „	Bryant & Co. -	Do.	
„ „ „	Robinson - -	Do.	
„ „ „	Turner - -	Do. - -	(Scutch manure). Extraction of fat from scutch.
Feb. 23 „	Bell - -	Stratford, Essex -	Manufacture of sulphuric acid.
„ „ „	Hales - -	Do.	
„ „ „	F. Hempleman -	West Ham -	Blood boiling and drying.
„ „ „	Newton, Keate, & Co.	Sutton, near St. Helens, Lancashire.	Manufacture of sulphuric acid, phosphoric acid, &c.
„ 24 „	Hunt - -	Bow Bridge -	Bone boiling.
Mar. 20 „	Morris and Griffin	Wolverhampton -	Bone steaming, manufacture of sulphuric acid.
„ 21 „	Town Manure Works.	Bilston - -	(*Second visit.*)
April 1 „	Towns - -	Melton Mowbray -	Knackery.
May 13 „	E. Packard & Co.	Bramford, Suffolk	Manufacture of sulphuric acid and sulphate of ammonia.
„ „ „	J. Fison - -	Do. -	Manufacture of sulphuric acid.
„ 16 „	Thos. Vickers and Sons.	Manchester -	Bone boiling, size making, soap making.
„ 17 „	Walshe - -	Manchester, Abattoir.	Blood albumen making.
„ 19 „	Thos. Vickers and Sons.	Widnes - -	Manufacture of sulphuric acid.
June 1 „	Phillips - -	Leeds - -	Bone steaming.
Nov. 16 „	E. Cook - -	Bow Bridge -	Bone boiling, fat melting, soap making, &c.
„ 17 „	Bevington -	Erith Marshes -	(*Second visit.*)
„ 22 „	Jas. Gibbs & Co. -	Victoria Docks -	(*Second visit.*)
„ 23 „	Odam - -	Do. - -	(*Second visit.*)
„ „ „	Ohlendorf -	Do. -	(*Second visit.* Formerly Shroeder).
Nov. 28 „	Hereford Manure Company.	Hereford - -	Manufacture of sulphuric acid.
Dec. 4 „	J. Thomson & Sons	Glasgow.	
„ 8 „	Hart -	Hull & Wilmington.	
„ „ „	Hunter - -	Wilmington.	
„ „ „	Officer - -	Hull - -	Glue making.
„ „ „	Foster - -	Little Driffield -	Fellmongering, leather dressing and tanning.
„ „ „	Nicholson -	Do. - -	Fellmongering, flesh and bone boiling.
Jan. 31, 1877	James Coles -	Near Calne.	
Feb. 1 „	Spence - -	Dunball, Bridgwater.	Manufacture of sulphuric acid.
„ 2 „	Norrington -	Plymouth - -	(*Second visit.*)
„ „ „	Burnard, Lack, & Alger.	Do. - -	(*Second visit.*)
„ 3 „	Jas. Gibbs & Co.	Do. - -	(*Second visit.*)
„ 13 „	Proctor & Ryland	Birmingham -	Bone boiling.
„ 14 „	Gen. Scott's Works	Saltley.	
Mar. 15 „	Walton - -	Near Cambridge -	Knackery, flesh boiling, pig keeping.

ESTABLISHMENTS VISITED—*cont.*

Date.	Name.	Locality.	Other Businesses or Processes conjoined.
Mar. 26, 1877	Langdale - -	Newcastle-on-Tyne	Manufacture of sulphuric acid.
„ „ „	Burrell - -	Do.	
„ 27 „	Arthur - -	Greenock -	Manufacture of animal charcoal, knackery.
„ 28 „	J. Poynter & Sons	Do. - -	Manufacture of animal charcoal, and of sulphuric acid, sulphate of ammonia, &c.
„ „ „	G. J. MacFarlane -	Brediland, Paisley	Manufacture of animal charcoal and of sulphate of ammonia.

Importance of the trade.

This manufacture ranks among chemical trades second only to alkali making in importance, in size of the establishments, and in respect of the number of persons and capital embarked in it. It is, therefore, not without some sense of diffidence that I approach the subject, which I should scarcely have been in a position to treat of at all, had it not been for the cordial assistance I have received from the manufacturers themselves, and the large amount of information respecting their trade and its details that they have been good enough to give me. To some of them I am under very great obligations in this respect, and I may especially mention Mr. Burnard, of the firm of Burnard, Lack, and Alger, of Plymouth; Messrs. Gibbs, of Victoria Docks; and Mr. William Vickers, of Manchester and Widnes. The last-named gentleman has very kindly assisted me by reading through the proof sheets of this section, and freeing the report, as I hope will be found to be the case, from technical errors. One difficulty I felt (and it is an initial difficulty) was in deciding what was to be regarded as an artificial manure in the sense of this section, and whether I ought to include what are ordinarily termed "composts," that is to say, mixtures of excrement, human or otherwise, with other ordinary refuse matters, such as ashes or litter. In deciding this question I have arrived at a compromise, and have simply consulted the convenience of the inquiry by deferring to a later section the consideration of the manufacture of those manures which are made by mixing human excrement, simply or principally, with the materials furnished during the collection of town refuse by local sanitary authorities or their contractors. On the other hand, I have found it convenient to include in this section some of the processes by which human excrement is utilised for the manufacture of manure.

Materials used.

The list of materials used in the manufacture of artificial manures is a long one. They may in general terms be described as phosphatic materials, nitrogenous or ammonia producing materials, saline materials, and dryers or deodorants. The phosphatic materials used are coprolites, apatite, phosphorites, South Carolina, French, and other mineral phosphates, some having a bone origin and containing fossil bones, Mejillones, Sombrero, and other phosphatic guanos, and bones boiled and then crushed, bone char, and bone char-dust from sugar refineries and manufactories of animal charcoal, calcined bones, sugar scum (the pressed residues of filtration of solution of raw sugar), &c. These materials also supply other useful elements to the manure. Sugar scum may not only contain the solid impurities of raw sugar, but, when

Phosphatic.

blood is used in refining sugar, it also contains the coagulable constituents of this substance: it also contains bone-char when the char dust is utilised by mixing it with the solution of sugar in the "blow-up" pan. The scum of Hills, Garton, & Co., of Southampton, is said to contain from 18 to 20 per cent. of phosphate of lime. The nitrogenous materials in use are such as these, viz.: ammoniacal guano, blood, (either in the form of wet or dried clot), sometimes flesh (horseflesh or diseased or putrid meat, boiled or unboiled), and offal from slaughter-houses, leather, bits of skin and wool from trotter boilers, &c., shoddy, scutch (the refuse from glue works), occasionally night soil, &c. The saline materials are common salt, nitrate of soda, sulphate of ammonia, &c. The dryers and deodorants are such substances as gypsum, soot and flue dust, the ashes of burnt tan, &c. The materials of the manure are selected from among these according to the nature of the manure required, the peculiarities of the trade of the manufacturer, their abundance or the facility with which they are obtained and their relative prices. In making them into manure sulphuric acid or occasionally hydrochloric acid is used.

On Effluvium-Nuisances, by Dr. Ballard.

Nitrogenous.

Saline, &c.

The following analyses of some of the materials used (as I am informed) in this country, may be usefully quoted in relation to the subject of this report, especially as showing the variations in the proportions of lime and fluoride in the phosphates. They are taken from Voelcker's paper in the journal of the Royal Agricultural Society (1875), from Dr. Morfit's work on mineral phosphates, and from other sources, published and unpublished:—

Various analyses of phosphates, &c.

Analytical Table of the Comparative Composition of some Natural, Crude Phosphates of Lime.

(*From Morfit's Work*).

Components,	Apatite from Norway. (*Voelcker.*)	Phosphorite from Spain. (*Ogston.*)	Phosphorite from Germany. (*Fresenius.*)	Bone ash from South America (*Morfit.*)	Bone black from sugar refineries. (*Morfit.*)	True Coprolites, Cambridge. (*Way.*)	False Coprolites, Suffolk. (*Herepath.*)	Marlstones of South Carolina Phosphate (*Morfit.*)
Bone or tri-phosphate of lime and magnesia.	90·74	80·68	74·64	70·31	58·10	57·09	55·49	52·21
Neutral or di-phosphate of lime.	—	—	—	—	—	—	—	—
Carbonate of lime	—	4·26	3·43	10·82	8·80	13·27	13·40	14·32
Lime, with organic acids, silica, and alumina.	4·59	1·83	1·34	·79	—	3·41	—	
Fluoride of calcium	—	·11	5·26	—	—	4·33	1·43	—
Chloride of calcium	1·61	—	—	—	—	—	1·66	—
Phosphate of alumina	1·66	—	—	—	—	5·57	5·12	8·89
Phosphate of iron		—	—	—	—	1·78	1·61	
Oxide of aluminum	traces	·50	1·03	·60	—	2·14	·80	
Oxide of iron	—		6·42		—	traces	traces	
Sulphate of lime	—	—	—	—	—	·80	·70	—
Potassa salts	—	—	0·58	·20	·80	·61	·65	—
Soda salts	—	—	0·52			—	—	—
Organic matters	—	—	—	8·42	8·60	4·05	6·26	8·00
Water—constitutional	—	—	—					—
„ accidental	0·43	·20	2·45					3·05
Carbon	—	—	—		19·50	—	—	—
Sand and silica	1·64	12·34	4·83	9·20	4·00	6·93	12·45	13·96
	100·67	99·92	100·55	100·34	99·80	99·98	99·57	100·43

Wicken (Cambridge and Bedfordshire) Coprolites. (*Morfit.*)

Moisture		1·66
Loss by ignition		2·97
Sand, silica, and pyrites		24·46
Fluoride of calcium		2·02
Sulphate of lime		1·53
Carbonate of lime		10·16
Lime (as silicate and organate)		6·40
Tri-phosphate of lime		35·66
Oxide of iron	7·56	
Alumina	4·07	14·30
Phosphoric acid	2·67	
		99·16

Coprolites from Pas de Calais. (*Morfit and B. W. Gerland.*)

Moisture		0·610
Sand, pyrites, &c., insoluble in H.Cl.		33·340
Silicic acid		1·490
Fluoride of calcium		2·100
Sulphate of lime		2·487
Carbonate of lime		11·360
Lime, as silicate, &c.		7·360
Tri-phosphate of lime		29·150
,, of magnesia		2·552
Oxide of iron	2·11	
Alumina	2·730	10·541
Phosphoric acid	5·700	
		100·990

Boulogne Coprolites (*detailed composition*).

Voelcker.

	Samples.				
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Moisture	·84	·79	1·08	1·18	1·74
Water of combination and loss on heating	3·14	3·24	3·08	1·91	1·04
*Phosphoric acid	21·06	21·27	21·27	20·70	17·69
Lime	33·06	35·38	33·58	30·41	31·12
†Carbonic acid	3·55	5·25	4·52	3·94	5·13
Sulphuric acid	6·81	·89	·90	3·24	·85
Fluorine and loss in analysis		2·08	2·77		4·96
Magnesia	·58	·25	·69	·83	·56
Oxide of iron	2·89	3·63	3·54	6·24	3·52
Alumina	3·09	3·66	3·64	5·39	4·94
Insoluble siliceous matter	24·98	23·56	24·93	26·16	28·45
	100·00	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	45·97	46·43	46·43	45·19	38·61
† ,, carbonate of lime	8·07	11·93	10·27	8·95	11·66

Cambridge Coprolites.

(*Voelcker.*)

	Samples.			
	No. 1.	No. 2.	No. 3.	No. 4.
Moisture	2·30	3·79	1·19	1·13
Water of combination, &c.	1·50		1·99	2·87
*Phosphoric acid	26·05	29·14	25·80	26·15
Lime	43·68	45·05	41·47	41·91
Oxide of iron and alumina	18·70	19·68	19·42	17·84
Insoluble siliceous matter	7·77	2·34	10·13	10·10
	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	56·87	63·60	56·3	57·08

Fluorine not given but most coprolites contain a good deal of this element.

Canadian Phosphates.
(Voelcker.)

—	Samples.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Moisture, water of combination, and loss on ignition	·62	·10	·11	1·09	·89	1·83
*Phosphoric acid	33·51	41·54	37·68	30·84	32·53	31·77
Lime	46·14	54·74	51·04	42·72	44·26	43·62
Oxide of iron, alumina, fluorine, &c.	7·83	3·03	6·88	13·32	12·15	9·28
Insoluble siliceous matter	11·90	·59	4·29	12·03	10·17	13·50
	100·00	100·00	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	73·15	90·68	82·25	67·32	71·01	69·35

Spanish Phosphorite (*detailed composition*).
(Voelcker.)

Water	3·59
*Phosphoric acid	33·38
Lime	47·16
Magnesia	traces.
†Carbonic acid	4·10
Sulphuric acid	·57
Oxide of iron	2·59
Alumina	·89
Fluorine and loss in analysis	4·01
Insoluble siliceous matter	3·71
	100·00
*Equal to tribasic phosphate of lime	72·87
† „ carbonate of lime	9·31

Rich Bordeaux Phosphate (*detailed composition*).
(Voelcker.)

—	Samples.	
	No. 1.	No. 2.
Moisture	2·28	3·28
Water of combination	2·52	1·24
*Phosphoric acid	35·51	33·72
Lime	47·81	44·23
Magnesia	·12	1·74
Fluorine (by difference)	·89	
†Carbonic acid	5·06	3·26
Sulphuric acid	·64	—
Oxide of iron	2·80	2·66
Alumina		6·42
Insoluble siliceous matter	2·37	3·45
	100·00	100·00
*Equal to tribasic phosphate of lime	77·52	73·61
† „ carbonate of lime	11·50	7·40

Effluvium-Nuisances, by Dr. Ballard.

South Carolina Land Phosphate (*detailed composition*).

(*Voelcker*).

—	Samples.	
	No. 1.	No. 2.
Moisture	2·78	5·38
Water of combination		1·79
*Phosphoric acid	24·15	24·66
Lime	35·78	37·18
Magnesia	·57	·76
Oxide of iron	3·99	4·15
Alumina	3·20	4·90
†Carbonic acid	2·91	4·08
Sulphuric acid	1·84	not determined.
Alkaline chlorides (common salt)	2·15	—
Fluorine and loss	3·50	2·05
Insoluble siliceous matter (fine sand)	19·13	15·05
	100·00	100·00
*Equal to tribasic phosphate of lime	52·72	53·83
† „ carbonate of lime	6·61	9·27

South Carolina Phosphate.

(*Morfit and B. W. Gerland.*)

Moisture	1·11
Organic matter	1·34
Insoluble, silica, sand, &c.	11·56
Pyrites	1·24
Silica, dissolved by H.Cl. (*sic*)	·86
Fluoride of calcium	2·62
Sulphate of lime	4·11
Carbonate of lime	14·02
Lime as organate, silicate, aluminate	9·11
Tri-phosphate of lime	42·13
„ of magnesia	4·43
Oxide of iron 1·83	
Alumina 2·07	8·39
Phosphoric acid 4·49	
	100·92

Sombrero Phosphate.

(*Voelcker.*)

—	Samples.			
	No. 1.	No. 2.	No. 3.	No. 4.
Moisture	8·14	7·03	7·63	8·92
Water of combination		1·64	1·49	
*Phosphoric acid	32·82	32·45	31·70	31·73
Lime	45·33	46·11	45·92	45·69
†Carbonic acid	5·58	7·33	7·30	5·99
Oxide of iron and alumina	7·14	4·29	4·87	7·07
Insoluble siliceous matter	·99	1·15	1·09	·60
	100·00	100·00	100·00	100·00
*Equal to tribasic phosphate of lime	71·65	70·84	69·20	69·2
† „ carbonate of lime	12·68	16·64	16·59	13·6

MEJILLONES GUANO. (*Furnished by Burnard, Lack, and Alger.*)

(*Voelcker.*)

Moisture	7·09
Organic matter	7·44
Phosphoric acid	33·97
Lime	37·01
Magnesia	2·83
Oxide of iron	0·69
Sulphuric acid	2·53
Alkaline salts (chiefly common salt)	3·21
Carbonic acid	2·76
Sand	2·47
	100·00

AMMONIACAL GUANO.

(*From Watts' Dictionary of Chemistry.*)

—	African.			American.		
Combustible organic matter, uric, oxalic, ulmic acid, &c.	39·5	37·0	42·59	11·3	36·5	35·0
Ammonia in the form of carbonate, urate, &c.	9·5	9·5		31·7	8·6	7·5
Fixed alkaline salts, sulphates, phosphates, chlorides, &c.	7·3	6·5	7·08	8·1	6·5	8·2
Phosphates of calcium and magnesium.	17·5	18·0	22·39	22·5	20·5	22·5
Oxalate of calcium	—	—	—	2·6	—	—
Sand and earthy matter	1·3	0·5	0·81	1·6	1·5	2·6
Water	25·0	28·5	27·13	22·2	26·0	25·0
	100·1	100·0	100·00	100·0	99·6	100·8

ANALYSES of SUGAR SCUMS used at various times by Barnard, Lack, and Alger, Plymouth.

(*From the Laboratory Book of the Firm.*)

1.
From *Liverpool*, ex *Lizzie May*, February 1873.

Moisture	44·00
Phosphate of lime	11·75
Ammonia	1·18

2.
From Finzel's, *Bristol*, August 19th, 1874.

Moisture	31·70
Organic matter	28·40
Phosphates	26·00
Ammonia	3·40

3.
From *Bristol*.

Moisture	45·00
Organic matter	17·27
Phosphate of lime	6·16
Oxide of iron	5·46
Carbonate of lime, sand, &c.	26·11
	100·00

4.
From *Bristol*, April 10th, 1866.

Moisture	57·63
*Organic Matter	20·44
Phosphate of lime	3·14
Oxide of iron and alumina	2·79
Carbonate of lime	6·17
Sand	9·54
Undetermined	·29
	100·00

* Containing N 1·22=NH_3 1·48, equal in dry scum to N 2·88=NH_3 3·49.

5.

From *Liverpool*, May 24th, 1875.

*Moisture and organic matter	71·08
†Phosphoric acid	4·90
Lime	7·53
Oxide of iron, Alumina, Carbonic acid, &c.	5·44
Sand	11·05
	100·00

* Containing N ·98 = NH_3 1·19.
† Equal to phosphate of lime, 10·80.

6.

From *Liverpool*, April 19th, 1876.

Water	25·82
*Organic matter	30·95
Phosphoric acid	7·14
Lime	11·82
Oxide of iron, Carbonic acid, &c.	9·93
Sand	14·34
	100·00

* Containing N 1·36 = NH_3 1·65, equal in dry scum to N 1·83 = NH_3 2·22.

The following is an analysis of the dried contents of the filter bags at Duncan's sugar refinery, Victoria Docks, obligingly furnished me by Mr. Newland, the manager, May 2nd, 1877. No blood is used at these works :—

Moisture (water)	3·50
*Organic matter	41·60
Ferric oxide	·72
Alumina	None
Phosphoric acid	2·03
Lime	22·50
Magnesia	1·83
Sulphuric acid	6·82
Chlorine	None
Carbonic acid	11·30
Insoluble residue	7·76
Alkalies and loss	1·94
	100·00

* Containing sugar 17·80
„ nitrogen ·50

When visiting the sugar refinery of Messrs. McFie and Son, at Liverpool, in May this year, Mr. Marquis, the manager, courteously gave me two samples of sugar-scum, one taken from the filter bags of the Vernon Street refinery, where no blood is used, and the other from those at the refinery in Batchelor Street, where several pails of blood are added to each charge of the "blow-up" pans. The following is the result of analyses of these two samples made by Dr. Dupré :—

	Moist as received.		Dry.	
	Vernon Street.	Batchelor Street.	Vernon Street.	Batchelor Street.
Moisture	48·58	46·95	—	—
Organic matters	20·82	29·55	40·49	55·70
Mineral „	30·60	23·50	59·59	44·30
	100·00	100·00	100·00	100·00
The mineral matter contains—				
Lime (CaO)	6·19	5·06	12·04	9·55
Magnesia (Mg. O)	0·92	0·34	1·78	0·64
Sand	16·12	10·47	31·35	19·73
Phosphoric acid (P_2O_5)	4·03	2·24	7·84	4·18
Oxide of iron, carbonic and sulphuric acid, &c. &c.	3·34	5·39	6·50	10·20
	30·60	23·50	59·51	44·30
The organic matter contains—				
Sugar	0·24	4·46	0·47	8·40
Nitrogen	0·48	0·89	0·94	1·69
Equal to ammonia	0·59	1·09	1·14	2·06

Comparing these results with the analyses of scum used by Messrs. Burnard, Lack, and Alger, it appears that as respects the only two samples, the analyses of which are so stated as to be comparable with the above, viz., Nos. 4 and 6, the quantity of nitrogen was higher than that contained in the scum from the Batchelor Street refinery, and much higher than that from the Vernon Street refinery, or from that of Messrs. Duncan. The inference to be drawn is that those two samples of scum were from refineries where blood was used, and perhaps the same is true of the remaining four samples. Probably scum from refineries where neither blood nor char dust are used would be of little value to the manure manufacturer. It is remarkable how much sugar was retained (as loss to the refiner) in the sample of scum from the Batchelor Street refinery, as compared with that in the scum from Vernon Street, where no blood is used. But double that quantity was contained in Messrs. Duncan's scum. It is probably a very variable constituent.

Sulphuric acid.

The sulphuric acid used in artificial manure making is universally or almost universally the acid from the leaden chambers in which it is manufactured, ordinarily known as "chamber acid," and having a specific gravity of about 1·45 to 1·6. The acid used for this purpose is now, I believe, invariably made from "pyrites," a sulphide of iron containing usually more or less copper. All large manufacturers of manure make their own acid, sending away the cupreous pyrites subsequently to its being burned, to manufactories where the copper is extracted. Such sulphuric acid is rich in arsenic, which exists in it either as arsenious or arsenic acid, or in both forms. It also usually contains some antimony.

Its ordinary source.

Presence of arsenic.

Since the presence of arsenic has of late been regarded as important in relation to the nature of the fumes evolved in manure making, it is necessary that I should say something more about it here. The most valuable recent contribution to the subject in this connexion is that of Dr. James Adams, of Glasgow,* of whose pamphlet I shall make free use. That arsenic is contained in all commercial sulphuric acid is a fact that has been known to chemists for many years, but Dr. Adams's merit consists in his having brought prominently under notice the fact that its proportion has increased with the adoption of "pyrites" as the ordinary source of the sulphur from which it is made. For full information on this subject I must refer the reader to his pamphlet, where at page 38 there will be found a table of 20 results of analyses of sulphuric acid, mostly chamber acid, 15 of which were made purposely for his inquiry. From a consideration of this table, Dr. Adams infers that 2 to 3 lbs. of arsenious acid per ton of chamber acid prepared from pyrites is a fair average estimate of quantity. One of the results represents an analysis of 432 samples daily taken from 108 vitriol chambers and then mixed together. The acid was exclusively acid manufactured from Tharsis pyrites (the most largely used in Great Britain of any) and "represents the best result as regards arsenical "contamination that a first-class establishment can produce." The analysis was made by an accomplished and trustworthy chemist, and the result was as follows, viz.:

Specific gravity of acid -	- 1·50.
Percentage of arsenious acid	- 0·0816.
Arsenious acid in one ton of acid	- 1 lb. 14 ozs. 370 grs.

* On the Presence of Arsenic in the Vapours of Bone Manure, by James Adams, M.D., &c., Glasgow. Edinburgh, John Menzies & Co. (Second edition), 1876.

On Effluvium-Nuisances, by Dr. Ballard.

In two determinations of arsenic in brown acid, specific gravity 1·755, manufactured from Rio Tinto pyrites at his own works, Mr. Burnard, of Plymouth, told me that he found as much as ·520 per cent. of arsenic (estimated as arsenious acid), a proportion equal to some of the largest per centages mentioned in Dr. Adams' pamphlet. Mr. Burnard states his belief that the acid made contains substantially all the arsenic originally present in the pyrites. The quantity of arsenic in chamber acid varies with the chamber from which the acid is taken, being much greater in the first than in subsequent chambers.

Designations of artificial manures.

Artificial manures pass under various designations according to the materials of which they are made. Thus there are "bone manure," where bones are largely used; "superphosphate," where coprolites or mineral phosphates are principal ingredients; "nitrophosphate," where superphosphate is combined with nitrogenous materials, "dissolved guano," where guano is mixed simply with sulphuric acid, &c. There are also known "blood manure," "scutch manure," and "poudrette," &c., &c. It will be convenient first of all to describe the manufacture of ordinary "superphosphate" or "bone manure" and then the various processes by which other principal kinds of artificial manures are made.

Process of manufacture of "superphosphate."

The mineral phosphates have first to be reduced to powder and the bones to be crushed, operations which it is not necessary here to describe. The manufacture consists in mixing them either separately, or more commonly both together in varying proportions with chamber sulphuric acid. I have never in the course of this inquiry seen this

General description of superphosphate works.

operation performed in the open air. It is always performed under a shed, or within buildings specially adapted to the trade. These buildings are often very lofty and extensive, covering one to three acres of land. But few of these establishments can be said to be really on a small scale; some turn out as much as 15,000 tons of manure or more per annum. They are to be met with in all parts of the country. The buildings are usually lighted and ventilated from the roof, or by windows in the side walls near the roof. In passing through them it is usually found that there is one part devoted to the storage of materials, another to the boiling or steaming of bones, another to the drying of bones after boiling, another to the drying of the phosphates about to be used, another to the crushing and screening of bones or phosphates, another to the actual mixing process, another to the reception of the manure as made, another to the various manipulations of additional mixings, or to the sifting and storage of the manure manufactured. And usually these several compartments are so arranged under the same roof at convenient elevations as to promote saving of time and labour. In addition, at most works a portion of the area of the works is devoted to the manufacture of sulphuric acid. The parts which most concern the subject matter of this report are those in which the mixing of the manure is carried on, in which the manure is received after mixing to set and cool, and in which the various subsequent manipulations are carried on.

The mechanical "mixer."

In the early days of superphosphate making the mixing used to be performed by hand labour in an open trough or vessel. But now it is almost invariably performed by machinery. For the most part the mixer (one or more according to the exigencies of the trade done) consists of a covered box, elevated upon a platform or placed on an upper floor of the works, and of such a size as to be capable of turning out from one to five tons at a mixing. It has within it a stirrer, usually consisting of an horizontal iron axis with iron arms, which stirrer is made to revolve by steam power. There are modifications in form of the mixer and stirrer in some works, but, the principle being the same, I need not describe them. It may suffice to say that the closure of the

mixer varies in completeness in different works. Sometimes it is completely shut up during working, and sometimes is more or less open at the places where the materials are introduced or where the charge has to be run out. These variations of closure may be important or unimportant as respects the production of nuisance, according as other arrangements are adapted or not adapted to the arrangement of the mixer. On Effluvium-Nuisances. by Dr. Ballard.

The dry materials are introduced into the mixer first. The way in which they are introduced varies. Sometimes they are thrown in by hand through a hopper at the top of the mixer or near the top on one side. In this case the communication between the hopper and the interior of the mixer may be free and uninterrupted, but in some works there is a valve interposed, and thus, the hopper being kept full, the material, as it is required, is let down into the mixer by opening the valve by an arrangement outside. In other works the materials are carried up from the floor below by means of a Jacob's ladder or endless band provided with cups, and is shot down a wooden channel into the mixer. At Burnard, Lack, and Alger's works at Plymouth, where the mixer represented in Plate 15 is perfectly close and tight, the materials brought from below by a Jacob's ladder are shot into a horizontal wooden channel which the material keeps constantly and completely full, and along which it is carried into the mixer by the agency of a screw working within the channel. Mixing.

The acid is usually run into the mixer from a gauged tank at a higher level than the mixer, but sometimes from a small measuring cistern at the side of the mixer. The operation of mixing occupies various times at different works. It rarely exceeds ten minutes, (at Morris and Griffin's works, I am informed, the mixing is prolonged to 15 minutes,) and sometimes occupies only three or four minutes. A pasty mass is produced which flows easily out of the mixer, and at the close of each mixing it is discharged into the place devoted below to its reception. For the purpose of discharge the mixer is provided at its lower part (the end or the middle, according to the shape and other arrangements of the mixer) with a flap door capable of being opened and closed by a mechanical arrangement worked from the platform on which the mixer stands.

In properly constructed works the manure is discharged from the mixer into a close chamber beneath (either immediately beneath or on one side), which is commonly known as the "hot-den." This chamber is usually constructed of brickwork and has a paved floor. There is a wide doorway which, while the den is being filled and for a varying time afterwards, is kept closed by a firm wooden door or partition fixed in its place by cross bars. The capacity of the den varies in different works, not only its cubical capacity, but also the superficial area of its floor as compared with its height. The lateral walls are commonly provided with openings which are closed by wooden doors or shutters. The roof of the den is sometimes the roof of the building, but in other cases it is formed by a floor or platform above, which can be removed when requisite for ventilation and light, either partially or entirely. The den is usually made of such a size as to hold one day's mixing, but sometimes two or three day's mixing. In some works there is only one den in connexion with each mixer, in other works there are two. In this latter case an arrangement is made by which the manure may be discharged into the one or the other at pleasure. As the manure in its semi-fluid state falls into the den it flows and distributes itself over the floor. The particular materials of the manure regulate the speed with which the fluid manure sets or consolidates. Manure made from materials which contain much lime sets more The "hot-den."

speedily than that made from materials that contain less lime; the setting quality being due to the sulphate of lime formed. Hence it happens that when materials rich in this ingredient are used, the manure lies much deeper about the spot at which it falls into the den than at a greater distance from it, and, if the floor space be large, will form more of a heap than an even uniform layer. In the den the manure remains to set, and to some extent to cool, and there it remains until the den is wanted for another mixing, or until the manure is wanted for preparation for sale. This period of retention in the den therefore may vary from 12 hours to three or four days, or even longer. When work is actively going on it is the practice in most works to fill the den one day and to dig out the manure the next morning. When the den is about to be emptied the door is taken down, the shutters of the window openings are removed, or the roof of the den formed by the floor above opened out, or skylights or trap doors are opened in the roof of the building when this forms actually the roof of the den. The object of all this is, first, to ventilate the den sufficiently for the workmen to enter, and, secondly, for light. The consolidated manure is then dug out and transferred in barrows, or, at some large works, in trolleys running on tramways, to another part of the building, where it is shot down in a heap for further manipulation.

Mixing by hand.

I have now described the usual practice and arrangements met with. But all works are not alike, either in the mode of mixing or in the disposal of the contents of the mixer. Thus the mixing may be performed by hand. This is commonly the case in very small works, where an open vessel is used into which the materials are put, and the whole stirred together with an appropriate instrument. The only large works where I have seen this done in a vessel entirely open are Proctor's works in Bristol. At Proctor and Ryland's works in Birmingham the mixing is performed by hand, but the tank forms the bottom of a chamber, having opposite openings, at which the workmen stand. These openings, as well as a third opening by which materials are introduced, are furnished with shutters and curtains of sacking. Plate 16 shows this arrangement.

At works where the mixing is performed by hand there is no close hot-den, but the manure is at once placed in a heap in some part of the building. At Proctor and Rylands the chamber of the mixer is virtually the hot-den, for I am informed that after the mixing is completed, the manure remains some hours in the mixing tank to cool and for the vapours to be disposed of in the manner to be explained presently. Manure made one day is not removed until the following day, and as there are three such chambers on the premises this can be done, each tank being large enough to allow of six or seven tons being made at one time. But there are other works, even works on a large scale, where mechanical mixers are in use, yet where no hot-dens are provided, but where the manure, as it is made, falls out from the mixer upon the floor of the building, where it is allowed to set and cool before undergoing further manipulation. There are others where the den provided is not sufficiently closed, the barrier put up being just high enough to enclose the liquid manure, but leaving a free space above by which the atmosphere of the den communicates with that of the general interior of the building, or having openings into the external air. The importance of all these variations will appear in the sequel.

Chemical action.

Smart chemical action occurs when the sulphuric acid is added to the other materials in the mixer, great heat is evolved, and an abundance of vapour is given off. The action commenced in the mixer is continued after its discharge, vapours continue to be eliminated, and heat to be

evolved as the chemical action goes on in the discharged mass. What the temperature actually attained in the mixer or den is I have not been able to ascertain, but it certainly is very considerable. The only observations on the subject that I have been able to find are those of Dr. Adams. He found by experiment in a factory where bones only were being used (in the manufacture of what is known as "dissolved bones") that the heat exceeded 240° Fahrenheit within three or four minutes after the addition of the acid. He made several attempts to ascertain the temperature of the manure within the den, but found it personally dangerous, and was compelled to desist. But it is probably sometimes higher than the temperature mentioned, since Dr. Adams found it to exceed 210° Fahrenheit in a heap of manure which had been left undisturbed for three or four days after leaving the mixer, and 180° in another heap which had been exposed to the cooling action of a fanning machine for 16 hours. In a similar observation made by Dr. Littleton, the Medical Officer of Health for Plymouth, during the discharge of a den at Burnard, Lack, and Alger's works, he found the temperature of the manure over 200°. I am not aware of any analyses of the vapours given off having hitherto been made, other than those contained in Dr. Adams' pamphlet, which were made with the object of determining the quantity of certain specified constituents. Watery vapour is given off in abundance, and fluoride of silicon is formed by the action of the sulphuric acid upon the fluoride of calcium and the silica contained in the materials used. But the fluoride of silicon cannot remain as such in the presence of condensing watery vapour, but is resolved at once into hydrated silica and hydro-fluo-silicic acid :— The following equation shows the nature of the decomposition: 3 Si F_4 and 4 H_2O=Si O_2, 2 H_2O and 2 (2 H F, Si F_4). Dr. Adams has also shown very satisfactorily that the vapours also contain arsenic from the arsenical sulphuric acid used in one form of combination or another. Without doubt some of the arsenic is evolved as arseniuretted hydrogen from the action of the iron of the stirrer upon the acid; but the greater part is probably evolved as chloride of arsenic. The chemical evidence of this fact is to be found in Dr. Adams' pamphlet, and is as complete as could be desired. The quantity of arsenic evolved as chloride will (using the same acid) be commensurate with the quantity of chlorides present in and decomposed with the materials of the manure; and according to Dr. Adams' showing it varies from 2 to 10 or more ounces (estimated as arsenious acid) for each ton of manure manufactured. Under any circumstances it must be an element of the vapours. Antimony, if present in the acid, also passes off in the vapours.

Heat evolved.

Vapours evolved.

By the kind permission of Messrs. James Gibbs & Co., Dr. Dupré has for the purposes of this Report, made at their works at Victoria Docks (the arrangements of which are described at p. 270) a chemical examination of the gases evolved during the manufacture of superphosphate from Carolina phosphates. The results of his experiments will be found in his report which, for the sake of convenience, I have placed in an appendix to this Report. They show briefly,—1°. That the vapours evolved contain fluorine in the form of tetrafluoride of silicon, none of it being evolved in the form of hydrofluoric acid. 2°. That the watery vapour evolved is sufficient in quantity to decompose the whole of the tetrafluoride given off with it into silica and hydrofluosilicic acid. The etching of the glass of windows and skylights of the factories, which is very commonly observed, is therefore probably the result of the evaporation of the hydrofluosilicic acid deposited upon them. 3°. That

when certain kinds of sulphuric acid are used the gases evolved contained distinct traces of arsenic. 4°. That at these works the greater part of the fluorine originally present in the phosphates employed, and also the greater part of the arsenic of the sulphuric acid, were contained in the superphosphate produced.

The manufacture of superphosphate is chiefly carried on between the months of November and April, but in some large works it continues all the year round.

The manufacture of other kinds of manure.

I may now pass on to the consideration of the mode of manufacture of other kinds of manure, where other materials, nitrogenous or otherwise, are used, either without such materials as are requisite for the manufacture of superphosphate or bone manure, or in conjunction with these materials.

Dissolved guano.

The manure known as "dissolved guano" is prepared by mixing sulphuric acid with Peruvian guano. This operation is usually performed in a mechanical mixer similar to that in use for superphosphate making. It is so made at Mockford's "Ordnance" Works at East Greenwich, where the mixer is capable of mixing six tons at each charge. The mixing is continued about half and hour, and the mixed material is discharged upon the floor of the capacious building in which the operation is carried on. At Ohlendorf's works, which are very large, near the Victoria Docks, there are three closed chambers in the floor, each of which is a circular pit, where the mixing is effected by means of a mechanical stirrer. The mixing of each charge is said to occupy a quarter of an hour, and the mixed material is then carried away in barrows to an adjoining very capacious shed, and is spread out upon the floor to cool. It is said to have a temperature of about 140° when thus spread out. There are abundant vapours given off in this process; and they consist mainly of watery vapour, hydrochloric acid, arising from the decomposition of the chlorides in the guano, arsenic, and some organic substance which imparts to the vapours a cheesy in addition to the acid odour.

Use of leather, shoddy, &c.

Leather and shoddy are commonly acted upon by sulphuric acid separately in an appropriate lead-lined tank, before being mixed with other materials of a superphosphate manure; but sometimes shoddy is used in the condition in which it enters the works and is mixed with the manure after it leaves the mixer. As respects the other nitrogenous materials, including excrement, they are usually thrown into the mixer with the phosphatic materials and mixed altogether there. This is the case, for example, at Braburn's works in Wednesfield, or, if it is not so now, used to be so formerly.

Use of fish.

Fish is sometimes dried or otherwise dealt with before being used. Fish heads (the refuse of fish curing) are in common use for manure. Drying of fish heads is usually performed upon kilns, or heated tiled or stone floors, and a most offensive odour is given off in the process. At Wilmington, near Hull, the fish heads are thrown into a deep bin formed by planking off a part of a shed, shoddy being put in alternate layers with fish, and the whole being freely sprinkled with sulphuric acid. Here the mass remains for 10 days or a fortnight, and the whole is then removed into the country. Whenever the mass appears to heat and evolves visible vapour, it is said that some additional shoddy is laid upon the mass. It is a very offensive process.

Use of blood.

Blood, if in the state of fresh clot, is mixed at once with the other materials, but when used dry it is commonly mixed by hand with the superphosphate on its removal from the den.

"Scutch" manure.

Gluemakers' scutch is usually treated with sulphuric acid and heat, to separate any fat it may contain, before being used for the manufacture of manure. This is sometimes carried out in an open vessel, where the scutch and acid are heated by free steam, but usually in vessels more or less completely closed. As the fat separates it is skimmed off, and when all of it is removed the residue is run off into a bay to cool and consolidate. At Bevington's works in Erith Marshes (and the same was the case at Brown's neighbouring works in 1873) the residue is run off into delves or trenches about 4 feet deep dug in the earth outside the works, where it remains for several months. It is then dug out and dried on kilns or brick flues. At Turner's works, in Bristol, the residue is run into a shallow tank within the building, and as soon as it is solid enough to be manipulated it is dug out and carried in barrows to a heap, partly under an open shed and partly not under cover. At these works the manure thus made is not dried by artificial heat, but is left to dry by spontaneous heating—some that was being screened at the time of my visit was still warm and smoking.

Manufacture of manure from excrement.

Poudrette making.

There is only one place in England in which I have seen human excrement being manufactured by drying into poudrette, viz., at the Town Manure Company's works at Bilston in Staffordshire. The process consisted in adding sulphuric acid to the excrement in the pails in which it came to the works, and then tipping the whole into one of Milburn's dessicators, from which, when it was evaporated to a sufficient consistence, it was removed to a drying floor heated by flues beneath. It was subsequently passed through a mill or disintegrator, and screened preparatory to being packed for sale. At General Scott's works at Saltley, near Birmingham, the excrement similarly received in pails undergoes an elaborate process for its manufacture into manure. The pails are first emptied outside the building upon a strainer so constructed as to allow all the urine and dissolved and fine suspended matter to pass through, but so as to retain any solid fæces, &c. The liquid matter strained off is pumped into an elevated tank for the supply of a boiler. This boiler is capable of dealing with 550 gallons of liquid matter at one charge, and is provided with a stirrer (at present worked by hand) to prevent incrustation. The boiler being charged, 80 lbs. of Dolomite (magnesian) lime is now added, and the whole is distilled by a fire below. The ammonia distilled off is conducted into an ordinary curtained saturator (such as will be described when the subject of the manufacture of sulphate of ammonia is under consideration) containing brown sulphuric acid. The fœtid vapours which are evolved in the saturator are carried through a worm-pipe in the supply tank above mentioned, partly for condensation and partly to warm the contents of the tank before running them into the boiler, and the condensed vapour is run off into the drains. The sulphate of ammonia thus made is evaporated in a shallow open leaden vessel on the top of the saturator, and as it crystallizes is drawn out and set to drain. In this distillation only five-eighths of the ammonia are boiled off. The residue in the boiler, when this quantity has been collected, is run off by a valve at the bottom and mixed with superphosphate obtained from another manufacturer, and is stirred up with it in large wooden vats. The product is then dried either by ordinary means or by pressure. The sulphate of ammonia is added to this as may be required. The solid matters originally separated by straining are mixed in a mortar mill with the ammoniacal phosphate and soot or waste char.

General Scott's works at Saltley.

Manure making at animal charcoal works.

A superphosphate manure is also made from the char dust at some animal charcoal works as an economical mode of utilizing it. Some of the bone oil is also used up at the same time. This is the case at Poynter's

works at Greenock. Bone-meal from Buenos Ayres is first rubbed down in a mortar mill with about 8 per cent. of bone oil, and then being mixed with the char dust is run through a continuous mixer (in which sulphuric acid, from sulphur, is added to it) into a den below. To the mixture in the den common salt is added, during which addition copious stifling fumes of hydrochloric acid are given off and fill the upper parts of the building. At Arthur's animal charcoal works near Greenock, where also horse-slaughtering is carried on, all the volatile products of the distillation of bones are mixed with boiled horse flesh, fish, blood, and char dust, partly in the pans in which the flesh is boiled and partly subsequently, and sulphuric acid being added, the whole is laid in a heap within the shed.

Manure making at knackeries.

On four occasions I have met with the manufacture of an artificial manure in association with a knackery. One of these was Kent's, near one of the railways running out of Bristol. The work was carried on in a wooden building within a few yards of the railway embankment. A hole is made in a heap of sweepings and scrapings from factory flues, and blood and flesh from the knackery are placed in it; sulphuric acid is poured on these, and the whole is then covered up with the sweepings. When it is considered that the action of the acid is complete, the whole is mixed up together by hand labour, bones dissolved with acid (from the knackery) are added, and, finally, some shoddy, and the mixture is left in a heap to dry by spontaneous heating, and is finally screened. The other was at a small knackery in the outskirts of Melton Mowbray. The flesh and bones of horses are chopped up and thrown into a cemented brick tank, where they are covered with sulphuric acid, more or less diluted, until they are dissolved or broken down. The more liquid parts are run off by a field ditch into an adjoining brook, and the soft material is removed to a shed where it is mixed into a manure with soot and gypsum. Another was Walton's works near Cambridge—most offensive works; the materials said to be used at the works are crushed bones, coprolites, blood, night soil, horse flesh (sometimes putrid), guts, fish, and refuse salt from the herring curers, liquor from the pans where horse flesh has been boiled, and sulphuric acid. These materials are mixed together by hand, and the mixture is discharged into an open pit within the building. At these premises pigs are also kept in a disgustingly filthy condition. The fourth was Arthur's works, previously mentioned.

Where organic matters containing a good deal of chloride of sodium are used in the manufacture of manures, the vapours necessarily contain more hydrochloric acid than where such substances are not used, and in addition various offensive organic compounds, the nature of which I am not acquainted with.

Effluvium-nuisances.

The offensiveness of the several processes described varies from none at all to that which constitutes one of the most intolerable of nuisances. On different occasions the interference or assistance of the Local Government Board have been solicited for the suppression of nuisances from works of this character. The most notable instances of applications of this kind of late years have been in respect of nuisances from manure works along the shores of the Thames in 1873, and in respect of similar nuisances at Plymouth in 1875. I reported to the Board fully upon the former of these cases in December 1873, but more briefly upon the latter of them, since at that time the present general inquiry had been set on foot. It is difficult to describe odours except by the use of similitudes. The offensive odour proceeding from superphosphate works, from works in which animal matters are used more or less freely, and from "scutch" manure works is, however, so distinctive that once

smelt it can never afterwards fail to be recognised. That from superphosphate making is pungent and slightly acid; by some persons it is called sickening, but its offensiveness and sickening quality are enhanced where such animal matters as blood, offal, or fish, especially if putrid, are employed in the manufacture of the manure. I know of no odour more horribly sickening than that which is evolved when sulphuric acid is mixed with human excrement. One of the most offensive works of this kind that has come within my observation, where animal matter of various kinds, and sometimes excrement, are used, is Bradburn's establishment at Wednesfield, upon which I reported to the Board in my report on the sanitary condition of that place in 1874. The smell proceeding from scutch manure works is described by some persons as putrid as well as sickening. Dr. Gordon, the principal medical officer of the Woolwich garrison, described to me the odour proceeding from the scutch manure works on Erith marshes as resembling, more than anything else, that which he had perceived in India when passing to leeward of the places in which the Hindoos burn their dead. To myself the odour resembles that of very decayed and putrid cheese. The odour from superphosphate works has to my senses something of the same character, especially marked when animal matters are used in addition to bones and phosphates. The distance to which the offensive odour may spread beyond the works varies with the various circumstances mentioned in the first part of this Report. It may be only perceived offensively within a radius of 100 yards or less around the works, or the odour may extend a mile or more beyond them. For example, the odour from the works of Morris and Griffin at Wolverhampton is said to be perceived offensively at Newbridge, a distance of $1\frac{1}{2}$ miles; while that from the Erith marshes "scutch" manure works was, on the occasion of my inquiry on the Thames, said to be an intolerable nuisance at the Woolwich barracks, a distance $4\frac{1}{4}$ miles. Loud and grievous complaints are made in the town of Plymouth, especially by persons residing about the Hoe, of the offensive odours from the manure works at Cattedown, a distance of about 1 mile, when the wind blows from that direction across the bay.

Effect upon health.

I have made such inquiries as were practicable as to the effect of these offensive odours upon the health of persons exposed to them. Replies to individual inquiries have been to the effect that prolonged exposure to the offensive odours produces feelings of depression, headache, indisposition for food, nausea, or even sometimes fainting. These, however, are ordinary results in sensitive individuals of the impression made by any specially offensive odour upon the nervous system. They pass off, however, with the intermission of their cause. I have not been able to ascertain that any permanent injury to health has followed even the frequent repetition of exposure to these offensive odours. Nevertheless, so long as the cause operates it does to a serious extent sometimes disturb the health of some individuals. The principal medical officer at the citadel at Plymouth, when I made my inquiry there, could give me no information, as the troops of which he had in charge had only recently arrived; but Dr. Yollin, of the 16th regiment, who was stationed there in 1874, states in a letter given to me by the Town Clerk of Plymouth, that notwithstanding the effluvia pass directly over the citadel in certain directions of the wind, the battalion had not been in a healthier state for the last 10 years than it was at the time he wrote. He adds, "The smell is intensely disagreeable, but luckily the barracks "are constructed on such an elevated and exposed position that these "vapours are never allowed time to settle down, but are blown over it "by the prevailing breeze. Were the barracks, however, built on a much

On Effluvium-Nuisances, by Dr. Ballard.

" lower and more confined space, I have no hesitation in saying that I " should consider the fumes would have a very deleterious effect upon " the health of the troops." Dr. Littleton, the Medical Officer of Health, could give me no more definite information in respect of the effect of the effluvia upon the general health of the civil population; nor could Dr. Finch, Medical Officer of Health for Charlton, nor Dr. Wise, Medical Officer of Health for Plumstead, in respect of the effluvia which, proceeding from the manure factories on the Thames, created a serious nuisance in their districts. Dr. Gordon, of the Woolwich garrison, stated to me in conversation that, in the event of any severe epidemic occurring, evil would, in his opinion, probably result from these nuisances, on the principle that anything which "upsets" the nervous system, predisposes an individual to suffer. But although I have made a good many inquiries in this aspect of the subject, I have failed to obtain any facts, so far as the ordinary epidemic maladies of the country are concerned, corroborative of this opinion. Dr. Davies, the accomplished Medical Officer of Health for Bristol, distinctly affirmed to me that these diseases spread no more extensively, and are no more fatal in St. Philip's Marsh, where manure nuisances abound, than in other parts of Bristol peopled by a similar class of persons. I am disposed to give great weight to the result of this gentleman's experience, as all would do who know the precision of his work and his logical mind. Moreover, throughout my inquiry, I have as yet found no reason to believe in any opposite view. Dr. Hingston, who has one of the largest medical practices at Plymouth, and has given some attention to this subject, tells me that he has never seen disease (other than temporary disturbance of health such as has been referred to above) produced in healthy people by exposure to the vapours proceeding from the manure works there, but he has seen sick people made materially worse. Especially in bronchitic and phthisical people (who sometimes come to Plymouth for the benefit of the climate), he has observed the cough to become more irritable after exposure to the effluvia. He says further, as to his personal experience, that the fumes from the manure establishments have distinctly caused smarting of his eyes at a distance of half a mile from the works. This, again, is a gentleman whose statements upon such a subject are entitled to much consideration. Further, I may add that I have not been able to discover that the workmen in manure manufactories suffer in any material degree, or in any definite manner, from their occupation. No doubt the statements of workmen on this subject must always be received with some qualification, but in the main I believe they have told me what is correct. But they take care not to expose themselves to the action of the concentrated effluvia. The most dangerous part of their work is the removal of the freshly made manure from the "hot den," but they take care not to work there until all the doors have been opened, and until a free current of air through the den has been established. For myself, what I chiefly experience in the most offensive parts of manure works, such as the den, is more or less smarting of the eyes.

Effects of concentrated effluvia.

Dr. Adams' case.

That exposure to the concentrated effluvia from a bone manure establishment may, notwithstanding, be followed by dangerous and even fatal symptoms appears to be shown by a case narrated by Dr. Adams in his pamphlet referred to above, the occurrence of which case indeed was the occasion of the pamphlet being written. The case briefly was that of a gentleman, said to have been in good health, who, while journeying by railway near Inverness, encountered at a small stopping place a volume of vapour, apparently there concentrated, from a bone manure works close by. He immediately became sick and faint, with

vomiting, which became bilious and continuous, and these symptoms were followed by abdominal pains and great prostration. Feeling better on the fourth day, he attempted to rise, but fainted away and died. It was suggested that this was a case of irritant poisoning from the vapours inhaled, but as no post-mortem examination was made, and as there are many latent bodily conditions of disease conceivable in which such symptoms, followed by a fatal issue, might result from a severe and continuous attack of vomiting (however induced), this view cannot be regarded as established. Dr. Adams goes further, and (p. 23) points out that the symptoms which characterised this gentleman's sudden illness accord with those of arsenical poisoning, but later in his pamphlet (p. 75) he says, "We" (*i.e.*, Dr. Littlejohn, Dr. Dunlop, and himself) "were satisfied that the conditions of advanced age and of the "nervous shock, caused by the inhalation of disagreeable and dreaded "effluvia, were important factors, and had aided materially the depres-"sing influence under which the sufferer succumbed. We, therefore, "by no means attributed the fatal result to arsenic alone. We were "satisfied that if there was to be anything like a real explanation of "Mr. Frazer's symptoms, it must be sought *in that aggregate of con-"ditions* out of which they had arisen. In short, we were of opinion, "as was also the magistrate who pronounced upon the case, that com-"mon sense and special professional knowledge alike directed clearly to "the conclusion that the immediate symptoms and fatal results were "due essentially to *irritant poison or poisons*, and that those poisonous "influences were contained in the manure vapours."

Sources of nuisance.

The offensive effluvia from artificial manure works may have their source, 1, in the reception of the raw materials, and their retention or accumulation on the premises prior to use; 2, in the preparation of the raw material for use; 3, in the process of their manufacture or mixing; 4, in the removal of the hot product; 5, in accumulations of the manufactured article, and the general odour pervading manure works at all times, and carried to a distance beyond them by the wind blowing over and through them.

Accumulations of raw material.

1. In accumulations of the raw material.—There is nothing offensive about accumulations of coprolites or mineral phosphates. The ammoniacal odour sometimes perceived from a heap of guano does not travel any considerable distance, so far as my experience goes; leather cuttings are inoffensive, and so in my experience is sugar scum. Large accumulations of recently boiled bones are very offensive, as I have pointed out under the head of "bone boiling"; and the disembarkation of putrid bones from canal boats for use at manure works has, in my experience, been a source of nuisance. Accumulations of night-soil, putrid flesh, putrid blood or blood clot (from blood-albumen works), or of putrid fish, are necessarily very offensive; and so also is glue makers' "scutch," if it arrives at the works long after leaving the pans and in uncovered vessels. This is, of course, especially the case in hot weather. Even dry fish mare (*e.g.*, the dried Manhaddan used at Morris and Griffin's works), not ordinarily offensive, may become so under some circumstances, as when it has become wetted during ship transit. Accumulations of shoddy are ordinarily inoffensive, but they may become offensive under some circumstances, as for example, when they become spontaneously heated, a process to which they are subject on account of the oil the shoddy may contain. For example, during my visit at Plymouth, I found an offensive rancid butyraceous odour, resembling that which I have experienced as proceeding from a heap of damaged wheat, to proceed from some shoddy recently brought upon the premises of Messrs. Burnard, Lack, and Alger. The shoddy was said to have been damaged

by sea water during its sea passage. The odour was strong just outside the works in the public road, and was disagreeably perceptible for some distance from the works. In one of the works near the Victoria Docks some shoddy was at the time of my visit smoking freely, and emitting an odour of burning animal matter.

The preparation of materials for use.

2. In the preparation of raw material for use.—I have elsewhere referred to the nuisance from bone boiling under the head of "bone boiling." The dissolving of leather and shoddy gives rise to offensive vapours, but not of a nature to be distinguishable outside the works from the other odours proceeding from them. The mixing of fish and shoddy with sulphuric acid is very offensive, and so in a still higher degree is the process of drying fish upon open kilns. These processes are especially disgusting where the fish is putrescent. The vapours proceeding from the extraction of fat from glue makers' scutch preparatory to its conversion into manure has also, when carelessly performed, been productive of considerable nuisance.

Mixing.

3. But one of the chief sources of nuisance from manure works is the process of mixing the materials. The vapours given off are, as I have pointed out above, irritant and offensive. When the manure is made in open vessels, these vapours escape into the atmosphere of the building, and through windows or openings in the roof, or through the unpointed tiling of the roof into the atmosphere outside. The same thing happens, although to a less extent, when the mixing is effected in mixers insufficiently closed, or not provided with due arrangements for drawing off the vapours from the mixer as they are produced. Where the vapours, however, are made to pass, as is now usually the case, through a flue into a chimney, more or less decomposition occurs within the flue, silica is deposited as a white snow-like material (sometimes to such an extent as almost or entirely to choke it up), and, where bones are used in any quantity, bone dust is deposited with it. The bone dust, however, is only carried mechanically into the flue, so that it stains the deposited silica only in the part of the flue nearest to the mixer. The silica and the bone dust deposited mechanically absorb any condensed water holding in solution more or less hydrofluosilicic acid. So much of the vapour as fails to become condensed and deposited within the flue passes off by the chimney shaft, and may give rise to offence wherever the vapours reach the ground.

Removal of manure from "hot-den."

4. Another principal source of nuisance is the removal of the manure from the hot den. At some works, as I have already stated, there is no hot den, but the manure is discharged from the mixer directly on to the floor of the building. In such a case as this, the action of the sulphuric acid on the other materials continuing, the same results follow as when the manure is made in an open mixer. When I visited Purser & Co.'s works at Millwall this proceeding was going on at one part of the building, and large volumes of steam of the ordinary offensive odour were issuing from the roof, and would continue so to issue until the manure became sufficiently cold to give off no large bulk of vapour. The principal use of the closed hot den is that it obviates this continued escape of the vapour which is formed during the reactions going on after the manure has been discharged from the mixer. If the manure is permitted to remain long enough in the den to become cold or nearly cold, it may be removed without giving rise to offensive effluvia of a serious character. But in establishments where much work goes on, and especially in the busy season of the year, this is, under present arrangements, said to be impracticable; and the manure is removed hot, or more or less warm, according to the shorter or longer time it has lain in the den; and then the vapours which, under long retention, would have become con-

densed, are given off into the atmosphere, and escape from the den into the air outside through the openings provided for tight and ventilation. It is remarkable how long a bulk of manure will remain hot in the den. It is still sufficiently hot to emit offensive fumes on removal at the end of three days from mixing, and probably, in some cases, much longer. I had, when at Plymouth, a personal experience of the nuisance arising from the removal of the hot manure at Norrington's works, at a time when no actual mixing was going on, but when the contents of one of the hot dens were being dug out, carried through the open air to the warehouse, and shot down through the roof. I have some reason to think that at Norrington's lower works this process is more offensive and more productive of nuisance than even the mixing.

On Effluvium-Nuisances, by Dr. Ballard.

5. But apart from the processes of mixing and removal from the hot den, there is commonly, even when no work is actually in progress, a general offensive smell issuing from establishments of this character which is sufficient in most cases to proclaim their immediate vicinity. This smell, which usually pervades the interior of the building, is due partly to the stirring up of the manure in the manipulations and mixings which take place there, and which favour the escape of pent-up vapours either retained mechanically in the masses removed from the den or which may have been generated after its removal for storage, partly to the odour which from long use has become attached to all parts of the inner surface of the works, and partly to the presence of stores of the manure from which vapours continue for a long time to be evolved. It is, however, a comparatively trifling affair. Nevertheless the offensive odour from this source may travel to a considerable distance. For instance, at my last visit to Hill's manure works on Greenwich marshes, I perceived the odour quite distinctly at a distance of full half a mile in the direction towards which the wind was blowing. On arriving at the works I found that no mixing was going on, but there was a quantity of manure which had been discharged upon the floor on occasion of the last mixing, about a week previously, and was being dug away for screening. It was hard but still warm. The nuisance is much greater, however, in some works where much organic material is used and no deodorant is added to the manure. In "scutch" manure works, such as Turner's at Bristol, where the manure is heaped up to dry by spontaneous heating, the exhalations from the accumulation are very offensively perceptible for a long distance from the works, and, except through changes in the wind, the nuisance is not intermittent like the nuisance from superphosphate works. Even after the manure has become dry enough to be screened, the heating, with evolution of offensive effluvia, still continues. But I am bound to add that this mode of drying, offensive as it is, is not nearly so offensive as the process of artificial drying which I saw pursued at the works on Erith marshes, and which appeared to me to be the main source of the intolerable nuisance from these works which was complained of by the Woolwich garrison.

General offensive odour from works.

I have now to describe the means which have been adopted in the works which I have visited for obviating or minimising the nuisances referred to, and such as have presented themselves to my mind as likely to bring about this result. In establishments where the manufacture is conducted on a small scale, little or nothing is attempted in this direction; and the same may be said also in respect of a certain number of establishments where the manufacture is conducted on a large scale. With respect to some of the latter, however, such as the works at Bramford in Suffolk, and those at Redbridge, Nursling, and Eling, near the head of Southampton Water, it may be said that the adoption of special means

Modes of preventing nuisances.

of preventing nuisance (considering that, so far as I have been able to gather, no serious injury is done to vegetation by the vapour emitted) is unnecessary. These and similar works located in an open country district with few or no dwellings within a mile or two of them, such as there are being much scattered, can scarcely be much nuisance to anyone. Such places are naturally the proper places for setting up offensive businesses.

1. From raw materials.

1. As to the prevention of nuisances from raw materials. No objection can properly be raised to the bringing of offensive matters to manure works. It is the proper place to bring many of them to, and the utilisation of refuse matters is a source of much wealth. But they should be brought in an inoffensive manner, should be stored so as not to be offensive to the neighbourhood, and used up as speedily as possible. When describing some other offensive businesses, *e.g.*, "glue making," I have shown how the refuse matters from them may be, and sometimes are, transmitted without causing nuisance. The reception of scutch at the works at Erith marshes was some years ago, (when I made a report to the Board upon some offensive business on the banks of the Thames), one source of the nuisance complained of; but since that time one of the establishments visited has ceased to manufacture, and at the other (Bevington's) the scutch is now received fresh at the works, packed in palm oil drums, and closely fastened down. Their transmission in closed barrels or covered carts or barges, and their storage under cover in close buildings or receptacles are, when practicable, an obvious precaution against nuisance. In other cases an efficient protection against the creation of nuisance might be found in covering the offensive material with some cheap deodorizing powder which would not damage the manure to be manufactured from it; sulphate of lime, charcoal in some form, or even earth patted down upon the heap might, for instance, be used. The best modes of dealing with recently boiled bones have been already described under the head of "bone boiling." Night-soil should be stored either in the covered privy pans in which it is received, or in well-cemented pits closely covered, from which it may be pumped as required for use.

2. From preparatory processes.

2. As respects nuisances from the processes to which raw materials are subjected preparatory to mixing them with other substances into manure, I need only refer to the following:—*a*. Any nuisances from the dissolving of shoddy or leather may be minimised or altogether prevented by the use of steam heat in the process, and by carrying the fumes into a sufficiently tall chimney shaft. *b*. The nuisance from mixing fish with shoddy and sulphuric acid may be prevented by performing the process in a closed building from which the offensive air is drawn off through a fire (as practised at Musk's cod-liver oil manufactory at Sculcoats, p. 88). *c*. The nuisances from drying fish can only be abated by adopting means of drawing off the moist offensive air by means of a fan or chimney draught, and conducting it through a fire, or first through a condenser of some effectual kind, and then through a fire. I saw a curious attempt made at Hart's establishment at Wilmington, near Hull, to abate the nuisance of kiln drying. In a building provided for the purpose is a kiln or stone floor heated by flues beneath. It forms the floor of a close chamber, about 13 yards square and 6 feet high, the roof or ceiling of which is made of stout laths or narrow planks of wood with narrow spaces between them This ceiling forms the floor of a chamber above, on which is laid first a layer of damaged cockles and above this sawdust moistened with sulphuric acid. This layer is renewed once in two or three months, and then goes for mixing with manure. It is supposed that the warm vapours from the kiln

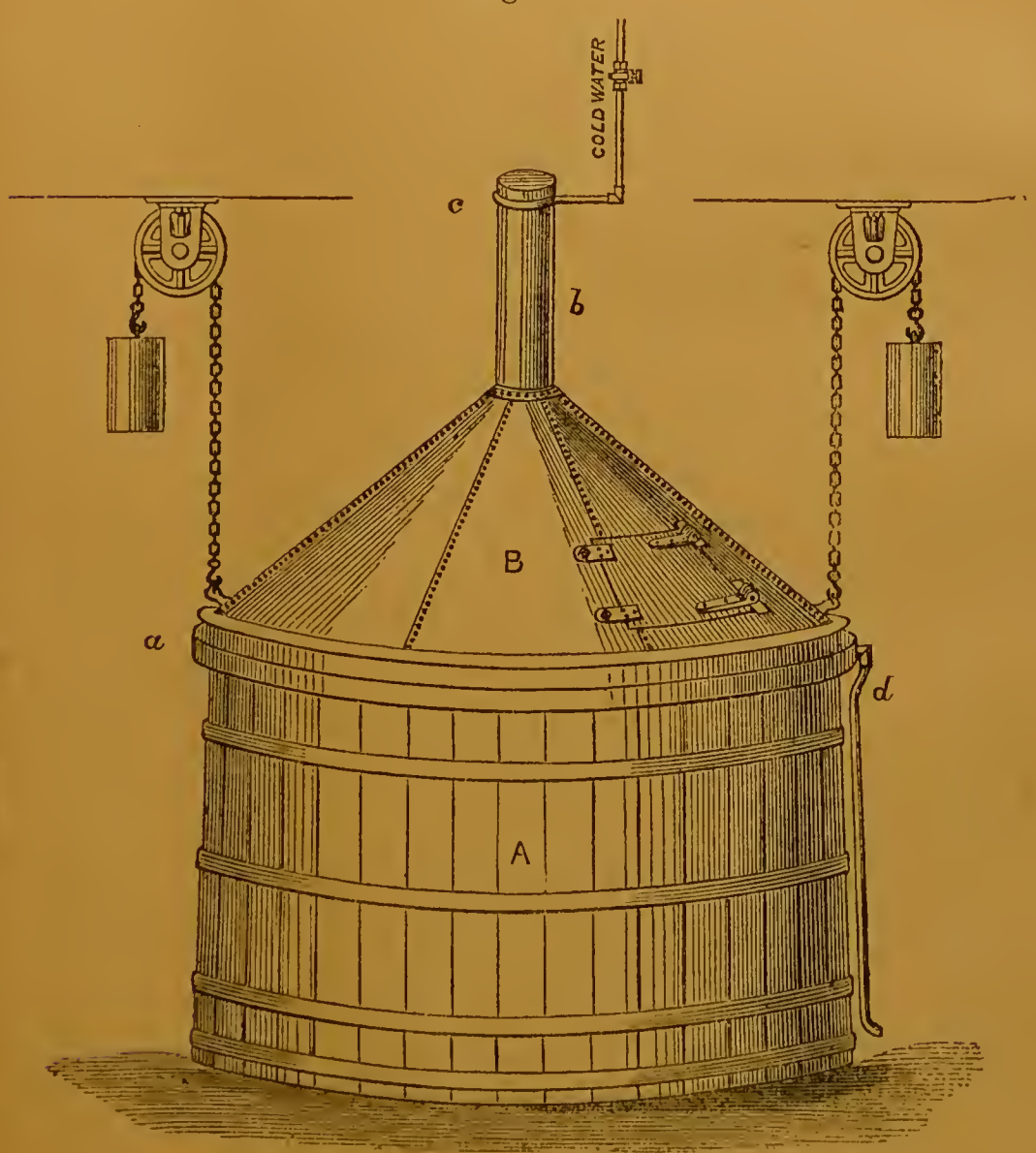
Leather and shoddy.

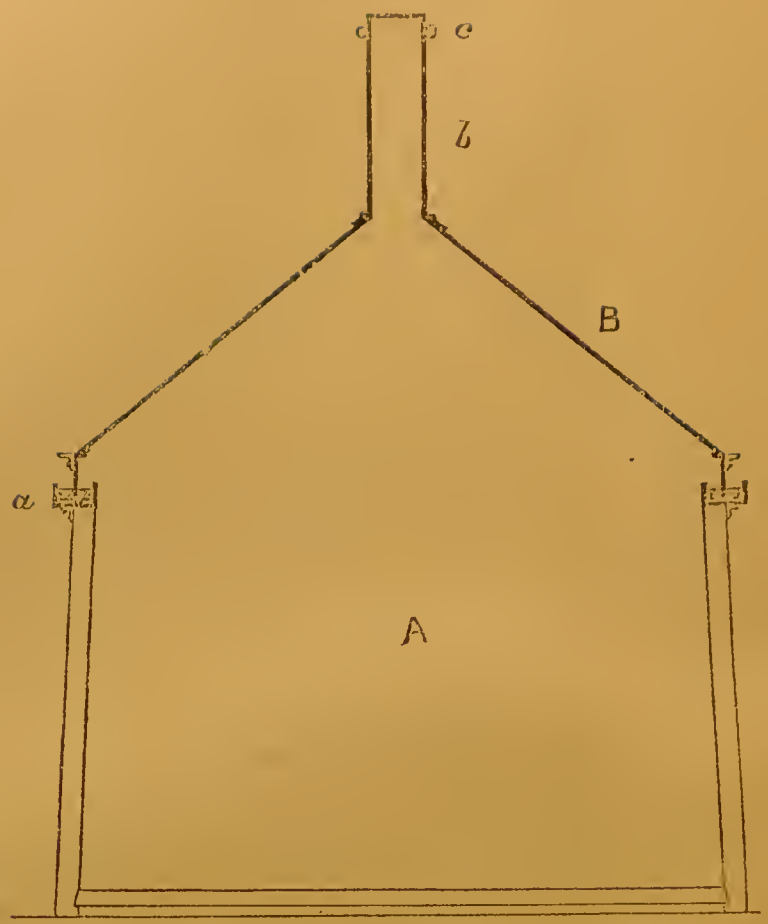
Fish.

passing up between the laths, and also those from the layer of cockles, are absorbed by the sulphuric acid. To a certain extent no doubt some such action is exerted, but, while the nuisance is considerably lessened, the proceeding does not altogether prevent the diffusion of the offensive smell through the works and in the immediate neighbourhood. For drying fish, probably the best apparatus is Milburn's dessicator, when it is provided with such means of carrying off and burning the evolved vapours as I shall describe presently as having been in use at the poudrette works of the Town Manure Company at Bilston, p. 172. *d.* There are three modes of dealing inoffensively with scutch for the removal of fat, which I have seen in use at different works. The principal point, however, to be attended to is to deal with the scutch at a very early period after it has been removed from the glue pan. One of the methods I refer to is that adopted at Turney's glue works in Stourbridge. The apparatus used is represented in the subjoined drawing and sectional plan (Fig.5). The scutch mixed with acid is heated by free steam in a large pan A, provided with a rim *a*, containing water, into which dips the edge of a conical cover B, so as to form a water lute when the cover is let down. A short length of pipe *b*, closed at the top, rises from the apex of the cover, and it is surrounded by a ring of perforated pipe *c*, from which cold water constantly flows in a stream over the outside of the cover into the grooved rim of the pan, from which a waste pipe *d* carries it away. By this means the steam within is condensed and runs down the inside of the cover into

Scutch.

Fig. 5.





the rim. The fat is ladled out and the residue is run off into a covered tank outside the works to cool. Another mode is that now adopted by Messrs. Bevington and Proctor at their scutch works at Erith marshes, one of the establishments complained of as nuisances in 1873. The apparatus used is represented in Plates 17 and 18. The scutch with a due quantity of brown sulphuric acid is introduced into a close cylindrical leaden vessel A, cased in wood and charged through a circular opening *a*, about 18 inches wide, at the upper part, which opening is closed during working by means of an iron cover firmly screwed down. Within is a stirrer B, the shaft of which passes through the centre of the top of the vessel. When the cylinder has been charged and closed up, steam at a temperature of about 220° is thrown in and is left on for about two hours. There is a safety valve *b*, but very little steam escapes by it, not enough to be perceptible by its odour outside the works. At the expiration of the two hours, the steam is turned off and the whole is left to settle until the next day. The fat is then ladled out through the charging opening, and the residue is run off into the delves through a discharge opening *c*, about 14 inches wide and 5 inches deep near the bottom of the vessel. During the steaming this opening is closed by a sliding door fixed firmly down by a cross bar and screws. The only nuisance that can arise here is during the running off of the residue; but the locality is very open and far from buildings; and, as a matter of fact, the nuisance from the scutch works on Erith marshes has not been made, so far as I can learn, a subject of complaint, since the scutch has been brought in a fresh condition in well-closed casks and this plan of extracting fat has been adopted. Another mode of dealing with scutch for the extraction of the fat is that pursued at Nickols and Son's works in Leeds. The scutch is dealt with while quite fresh from the pans. It is immediately put into a large tub with water and some sulphuric acid, steam is thrown in to separate fat which is taken off, and the scutch enclosed in coarse bags is then subjected to

pressure in a strong hydraulic press, close shut up with a door, while steam is thrown into the press. The fat pressed out flows off from the bottom of the press, and is collected and subsequently refined by remelting by steam heat. The pressed scutch has little or no odour, and can be kept without heating or otherwise becoming offensive if stored under shelter. It is still fit for manure making.

3. From mixing.

3. As to the nuisances from the process of mixing. Of the offensive vapours given off during the mixing it may be said that some are condensible by cold, some soluble in, or decomposable by water, and the remainder destructible by fire. The only question then to be determined relate to the best mode in which these three agents—cold, water, and fire,—can be applied under the circumstances of manure works. The principal means in use in the manure works I have visited are long flues leading to a chimney stack, water towers or "scrubbers," and the furnace. But, when the mixer is not closely shut up, it is not sufficient to have such means provided without some motive power to draw the vapours from the mixer. The motive power in use is sometimes the draught of the chimney stack and sometimes a fan. With a well-closed mixer (such as is in use at Burnard, Lack, and Alger's works), the pressure exercised by the vapour therein may suffice for all practical purposes. I propose to show how far in my experience these several means are efficient, and what accessory arrangements are in use, or may be suggested, to ensure success. I will do this, as far as I can, by examples of actual working.

a. Use of a long flue.

a. In simple superphosphate making, the use of a *long flue* appears to suffice to prevent nuisance. So far as I have been able to ascertain by as full an inquiry as I could institute, it is completely efficient at the works of Thomas Vickers and Sons, in Manchester, and at the works of the same firm at Widnes. The long flue has also been adopted as a means of preventing nuisance at Messrs. Morris and Griffin's works in Wolverhampton and in other works, and as an accessory means it is in use in many other works.

The object of the flue is, by its cooling operation, to promote the condensation of the steam, which, in condensing, takes down with it the hydrofluosilicic acid formed; and to afford space and time for the depositions of these condensed vapours and of the silica, before they arrive at the chimney by which they would otherwise be discharged into the air outside the works. These matters are always found in flues proceeding from large superphosphate mixers and dens, and with them a notable quantity of arsenic. Mr. William Vickers, of Manchester, recently made for my satisfaction an examination of the vapours proceeding along his flues at his Widnes works. At a distance of about 216 feet from his mixer, notwithstanding the excellent arrangements for arresting deposit which I shall presently describe, he still found a very small but still estimable quantity of fluorine compounds, the mixing at the time the examination was made being in full operation. I mention this to show that even in his case the flue is not in any way too long, although it is continued 206 feet further to the bottom of his chimney shaft. Mr. Burnard, of Plymouth, tells me that he found arsenic in the flue leading from his den (which receives the vapours) to his condenser. Mr. Adams also gives in his pamphlet (page 52) a summary of an analysis of flue deposit in which a trustworthy chemist found in the moist deposit ·119 per cent. of arsenious acid. These are the most irritant of the various constituents of the manure vapours. I have no observations to show in what proportion, actual or relative, they are deposited at various distances from the mixer.

Description of flue arrangements at Vickers' works.

At Vickers' works in Manchester (see Plate 19) a short flue 12 inches square passes from the mixer to a wooden box or chamber, about 18 feet long and 3½ or 4 feet wide and deep, in which at equal intervals are three partitions dividing it thus into four subsidiary chambers or boxes. The partitions spring alternately from the top and from the bottom of the chamber, and there is a space left at the bottom or top, as the case may be, by which the subsidiary chambers communicate. At the bottom of each subsidiary chamber is a door through which the deposited silica or dust is from time to time removed. From this chamber or box there is a communication with the upper part of a brick tower about 14 feet 6 inches high and 2 feet 7 inches wide in either direction, which tower or chamber also has a communication with the "hot den." In this chamber more silica is deposited. There is a shorter brick chamber adjoining it with which there is a communication 4 feet from the bottom of the longer brick chamber, so that the silica which accumulates in the latter, falling below the communication, does not choke it up, and is removeable by a door at the bottom. From this smaller brick chamber the vapours pass into an underground flue 150 feet in length, which terminates in the chimney shaft having an elevation of 210 feet. The result of this is that the silica (the measure of decomposition of the fluoride) is deposited in great part in the wooden chamber and brick tower, the former being cleared out twice a week and the latter once a month; and that beyond the first 15 yards of the flue the amount of deposit is scarcely appreciable. The flue only requires clearing out about once a year. Wherever the silica may be removed it is so wet with condensed steam holding hydrofluosilicic acid in solution, that it may be pressed by the fingers into a paste. At the Widnes works the arrangement is very similar (see Plate 20). A 3-foot square wooden flue, rising from the top of the mixer, extends round the platformed part of the building in which the mixer is situated for a distance of 120 feet before it reaches the brick chamber or tower; and every 8 feet, in the course of the first 84 feet, is a partition rising from the bottom nearly to the top of the flue, so that there are 10 such partitions. The silica deposited in the chambers thus formed is removed at short intervals by raising the top of the flue. The brick deposit tower is of the same construction as at the Manchester works, and from it an underground flue, 3½ feet high and 2½ feet wide, passes a distance of 302 feet to the chimney shaft of the works, which is of an elevation of 135 feet. There is a damper to control the exit from the mixer, to which exit is given an area of a foot to a foot and a half, and there is another over the deposit tower with an opening of about 4½ feet. The wooden flue from the mixer is cleaned out once a week and the first part of the underground flue about once a fortnight. On opening the first part of the flue I found a deposit of about 16 inches, the result of a fortnights' working; and about 96 feet further a deposit of 10 inches, the result of 12 months continuous working. The motive power at both works is the draught of the chimney shaft, and it is sufficient to produce a strong draught down into the mixer when it is opened. Mr. William Vickers sums up the length of flues and the reason of differences at the two works thus in a letter to me: "At Manchester we have, therefore, 22 feet from mixer "to wooden chamber, which is 18 feet long to a tower 14 feet 6 inches "high, and 150 feet to chimney, total length 204 feet 6 inches. At "Widnes 120 feet of wooden chamber (or flue), 18 feet of tower, and "302 feet of flue to the chimney, total 440 feet. At Manchester we "mix on an average 100 tons of manure per week; and, one half of "the raw phosphatic material being boiled bones, we have not the same

"amount of deposit to contend with as at Widnes, where it is nearly "all mineral phosphates and where the quantity made averages nearly "300 tons per week."

At Morris and Griffin's works.

At Morris and Griffin's works at Wolverhampton the motive power in use to draw the vapours from the mixer is the same as at Vickers, namely, the draught of the chimney shaft of the works. It is a rather higher shaft than that at Vickers' Manchester works, being 235 feet in height from the ground. The vapours from the mixer are conducted to an underground channel or flue 6 feet high by 3 or 4 feet wide without any baulks or divisions, which extends to a distance of 250 feet to the chimney shaft with which it is made to communicate. The flue is said sometimes to have in it 2 feet depth of the ordinary siliceous deposit. There are dampers provided for regulating the draught. The deposit in it is cleared out, it is said, about once in six weeks. The tall chimney stack was erected eight years ago. Prior to its erection the nuisance all around the works was very great, but since then the nuisance in the immediate neighbourhood has been greatly lessened, but offensive effluvia are now said to be perceived at a distance of $1\frac{1}{2}$ mile from the works where they were not before noticeable. They are not a very great nuisance there, but they are said to be unpleasantly perceptible. They are said to be a greater nuisance in some parts of Wolverhampton when the wind sets in the right direction, but this may be from the emptying of the den, or from some other part of the process than the mixing, which Mr. Fuller, the managing partner, says is only performed during three or four hours at night. The average weekly out-put from the mixer is about 300 tons. One charge for the mixer would consist of, say, 40 cwt. of phosphatic material, and 20 to 40 cwt. of chamber acid. The charges of mineral phosphate only would have about equal weights of acid and phosphates. The average time of each charge in the mixer is about 15 minutes, an unusual length of time, but a period calculated to favour the elimination of much of the vapours before the manure is discharged into the den. The superiority of the flue arrangements at Vickers' works appears to lie in the baulks introduced into the wooden box or channel into which the vapours first pass, in the tortuous course which the vapours have to pursue, and in the greater length of flue which they have to traverse. The course of the vapour is subjected to a variety of obstructions which serve to arrest its onward flow and afford opportunities for the re-action of the watery vapour on the gas it has to decompose, and for its condensation, as also for the arrest of the silica deposited which has to sop up the condensed matters.

b. Use of a cold water condenser.

b. The flue acts mainly on the principle of condensing the vapours by cooling; but in some works endeavours, more or less successful, have been made to condense them by the direct application of cold water. This is effected either by means of a shower or by means of a "scrubber," that is to say, a tower partly filled with some material over which a spray or shower of water is made to fall. Where this is the mode adopted, I have usually found the use of a moderately long flue, or of a fire, or of both, conjoined. Passing the vapours through a fire appears to be necessary for the entire destruction of organic vapours. The most successful of the arrangements for condensing by a shower of water are to be seen at Newton's works in Bermondsey and Hunt's works at Bow Bridge. Both these works were formerly sources of great nuisance, but they are not at all complained of now, so that the presumption must be that the means adopted to prevent nuisance have been successful. Newton's are comparatively small works, and the apparatus first put up was only tentative. From one end of the mixer an opening, the entire width of the mixer and about 15 inches deep, communicated

Newton's cascade condenser.

with a wooden channel which joined another similar wide channel proceeding from the hot den. At a distance of about 3 yards from the mixer this channel communicated with the upper part of a water tower, in which the vapours met with the shower. This tower was constructed of wood, was square with a diameter of 3 feet, and was 18 feet high. At the top of the tower was a cistern which was kept well supplied with water pumped into it in great abundance from a well upon the premises. The floor of the cistern was perforated like a colander with large holes, so that when water was pumped in, it fell down the tower in a heavy shower. It was so arranged that the water, after arriving at the bottom, was made to fall over an edge into a cistern below, in such a way as to form a broken sheet of water or cascade about 3 feet in height (through which the vapour had to pass), and it then flowed away by a brick drain with which the cistern communicated. From this drain there was a flue passing to the ashpit of the furnace of the boiler which works the steam machinery employed for pumping up the water and other purposes. The fall of the water produced sufficient vacuum to cause a strong draught from the mixer and hot den. Since my first inspection of these works, alterations have been made which the proprietor believes have rendered the apparatus more efficient than it was before. A series of wooden shelves springing alternately from opposite sides have been put into the tower and these shelves have attached to them at their sides vertical pieces, having for their object to direct the flow of water towards the middle of each shelf. In this way, instead of one shower of water, a series of splashing showers and easeades has been obtained, through all of which the vapours have to pass on their way to the drain. But with this change in the arrangement of the tower it has been found requisite to interpose a fan between the condenser and the fire. Plate 21 shows the arrangement, with the exception of the fan. Such an arrangement as this is only practicable where there is a similar abundance of water obtainable, but where this convenience exists nothing can be better. At Hunt's establishment the shower is not so heavy. From the mixer, from the hot den, and from all parts of his large buildings where bones are boiled and then dried by spontaneous heating, and where manure is made and stored, wooden square flues about 2 feet wide conduct vapours to a washing tower or chamber and thence to the back part of the ashpit of his boiler furnaces. At these works, however, it is necessary, from the deficiency of draught and the large capacity of the buildings to be ventilated, to use a powerful fan to draw off the vapours. These arrangements, which are quite efficient, were made under the advice of Dr. Letheby and myself some years ago. (See also "Bone boiling.")

Arrangement at Hunt's works.

"Scrubber" arrangements.

The use of a "scrubber," however, is far more common than the use of any such water tower as I have just described.

At Gibbs & Co.'s works.

Plates 22 and 23 show the arrangements for condensation at James Gibbs & Co.'s works at Victoria Docks. There are four mixers, two being used for mixing superphosphate and two for mixing guano. From the mixers and from the dens, at the places where the mixers discharge themselves into the dens, are square wooden flues or channels, varying from 133 to 35 feet in length and terminating at a fan. This fan draws off the vapours from the mixers and dens and drives them through the condenser or scrubber. The form and dimensions of the condenser are shown in the drawings. It is fitted within with several stages formed of squared, wooden bars, loosely fitted edge-wise into appropriate racks, and so laid that the rods of each pair of stages cross those of the pair of stages above and beneath, at short intervals. Above is a perforated leaden tray or colander supplied by a tap with water,

which water falls as a shower upon the intercepting bars within the condenser, and between them to the bottom of the condenser where it runs off to the drains. The vapours enter below and pass out by a short length of pipe above into the chimney shaft. At one side of the condenser is a closely-fitting door, the removal of which exposes nearly all of the interior. When the condenser was thus opened for my inspection, I found a considerable amount of siliceous deposit lying at the bottom of it, and on the several stages. The manager stated to me his opinion that the efficiency of the arrangement depended less upon the flow of water than upon the obstruction afforded in the condenser to the passage of the vapours, affording time for the decomposition of the fluoride, and arresting the products of the decomposition. Nevertheless it would be certainly less efficient than it is without the flow of water which serves, or ought to serve, to keep the passage between the bars free and to wash down condensed matters. It was at these works that Dr. Dupré made the observations recorded in the Appendix to this Report. He found that the gases after having passed the scrubber contained no appreciable traces of any fluoride compound, but they still contained traces of arsenic.

There is a very similar arrangement at the works belonging to the same firm at Plymouth. Here the mixer is near the end of a long building, and discharges into a den at the end of the building, the communication between the mixer and den never being quite closed. A short channel from the mixer conducts the vapours from it and from the den through the mixer to a fan which drives them along a 2-feet square wooden flue or channel, about 90 feet in length, to a condenser arranged similarly to that just described. About every 10 feet in the length of this flue is a cover, screwed down, which is removed, it is said, about once a month for the cleaning of the flue from deposit. The condenser, generally arranged with bars as in the London works, is differently arranged above. The vapours pass out through a channel which runs through the middle of the colander-like cistern above, by which water flows into the condenser. The colander, therefore, is ring shaped. While the condenser was open I had the water turned on, and found that very little flowed in consequence of the choking up of the holes in the colander. The foreman told me that they were quite aware of this defect, and that each time before working the holes were cleared. I have no doubt that this was a correct statement, since, although the condenser had not been cleaned out for a fortnight or three weeks (notwithstanding that work had been going on during that period) there was very little deposit in it—very much less than in that at the London works. This smallness of deposit was no doubt in part due to the greater length of the flue. From the condenser a flue, 16 feet in length, leads to the chimney shaft. It had not been cleaned out for two months, and I found in it along its whole length a deposit about one inch in depth. Hence some of the vapours must have escaped by the chimney stack, 80 or 90 feet high, although the greater part had evidently been arrested.

At Burnard, Lack, and Alger's works.

The most complete and apparently most effective "scrubber" I have yet seen is that in use at Burnard, Lack, and Alger's works at Plymouth.

Since these works have been made the subject of much unfavourable comment in Plymouth, and have been there regarded (and, as I believe, not very justly on all occasions) as the principal source of the manure nuisance complained of at the Hoe, and referred to in the memorial presented to the Board, I propose giving a full account of the works, while describing the efforts made by the proprietor to avoid the produc-

tion of nuisance. I have visited the works four times with an interval of a year between my second and third visit, and have altogether spent many hours in the works. The works in Sutton Road have been established about 16 years, and cover about two acres of ground. They are situated, in two parts, one on the north and the other on the south side of a public roadway, at the edge of the town, and close to the gas works, some ammonia works, some tar works, a candle factory where palm-oil is distilled and fat melted, and also a most offensive shoot of town refuse belonging to the Corporation; that is to say, they are close to a number of other offensive business establishments, the effluvia from which must also be wafted towards the town when the wind carries the manurial vapours in that direction. It is, therefore, quite possible that persons not sufficiently instructed to distinguish between different industrial nuisances, may sometimes have attributed to the manure works a nuisance which may really have had a different origin. I was informed by the firm that the materials which they use (varying them according to circumstances) are crushed bones (foreign), Carolina, Lisbon, and French phosphorites (chiefly), coprolites, Peruvian guano, shoddy, sugar scum, and gypsum. The sugar scum has in the mass a sweetish odour not at all unpleasant. Manure making is mostly performed on the north and south sides alternately. On both sides the mixer is of the same construction. It is a close box with the usual stirring arrangements, and it is fed through a channel packed full of dry material which prevents any exit of vapour in that direction, and which is moved on by means of a screw working in the channel as described in an earlier part of this section of my report. The acid is introduced in definite quantities by a pipe from the acid tank. No vapours can possibly escape from the box during mixing, or if they ever do, only quite accidentally. There is one close den below the mixer on the north side. It measures in superficial area 35 feet × 27 feet, equal (with the corners cut off) to an area of 800 feet, with an height of 12 feet, and is capable of containing 200 tons of manure—one or one and a half day's working. It is closed completely during the mixing by means of a large wooden door firmly barred up. On the south side there are two dens associated with the one mixer, and there is an arrangement by which the contents of the mixer may be discharged into one or the other as may be desired. These dens are capable of containing each about 90 tons of manure, and they are worked alternately. Each is roofed above by a wooden flooring, which at the time of working is sealed against escape of vapour, (and, as I took pains to ascertain, effectually) by a layer of dry materials. When closed the superficial area of each den is about 20 feet × 11 feet, and the height 14 feet. The mixing of each charge occupies about four minutes, and the mixed manure is discharged into the den by a valve worked from outside the mixer. There was no unpleasantly perceptible odour about the mixer while it was at work. I may now proceed to describe the condensing arrangements, premising that on both sides the manure and the vapours evolved are both made to pass into the den, which thus becomes a first large receiving and partly a condensing and deposit chamber for them. So much of the silica and hydrofluosilicic as condense there becomes mingled with the manure, and would exist there propably as hydrofluosilicic acid and silica only. Beginning my description with the works on the north side: There is, proceeding from the den, a short length (2 feet 6 inches) of 12-inch pipe leading from it to the condenser; and from the condenser there is an underground flue 50 feet in length leading to a fire. The condenser is constructed as shown in Plate 24, and is of the form and dimensions there indicated. It consists of three vertical chambers of

brick. The first contains nothing, but the second and third have at their lower halves perforated bricks, evenly but not too closely laid. Above is a tank well supplied with water for use in the condenser. There is an excellent arrangement for throwing in the water into the condenser. It flows by a pipe into each compartment. The bottom of the pipe is open, but capable of being closed entirely by means of a plate or button which can be raised against the opening by a screw working through the length of the pipe from above. When this plate is slightly lowered the water flows out in a thin sheet resembling an open umbrella in shape, and falls down through the chambers and loose perforated bricks at the bottom, whence it is carried away by the drain. The arrangement of the supply pipe is shown in Plate 24. After each working, a plug in the cistern above is opened, and a flush of water is sent through each chamber to clear it of any deposited silica. The vapours from the den enter the upper part of the first chamber, pass into the lower part of the second chamber, between the bricks, and enter the third chamber above the sheet of water through which, or through the spray from which, they must pass out among the bricks below to the underground flue leading to the fire. I examined this condenser while mixing was going on. In the first chamber the vapours were overpowering above the sheet of water; while in the second and third they are decidedly much less perceptible. The next day, when no mixing was going on, I had the third chamber opened below at *a*, and also the first 5 feet of the underground flue leading from it, and again another part of the flue about 34 feet from the condenser. The bottom of the condenser had not, I was told, been opened for five years, yet all I found was some slimy deposit upon the bricks, the passages through and between them being quite clear. There was no siliceous or watery deposit at either part of the flue which I had opened. I could not, however, satisfy myself that the fire exercised much effectual traction upon the vapours in the den; probably, therefore, the vapours passed through the condenser chiefly by force of their own pressure, such as did not so pass being condensed within the den. Were it not, therefore, for the careful closure of the mixer, there would have been during mixing much escape of vapour into the building, but this is obviated in the manner I have already explained. The arrangements on the south side are a little different, although essentially similar. The two dens communicate by a 12-inch pipe from near the roof of each with a deposit tower. The length of the pipe from the nearest den is about 2 feet, of that from the further den 20 feet. The tower into which they open at its upper part is 2 feet square (internal measurement), and its total height is about 15 feet, and it descends about 4 feet below the level of the floor of the works. From the bottom of this tower, an underground flue 44 feet 6 inches in length leads to the condenser. During the greater part of its course it is of brick 2 feet high (internal measurement) at first, but gradually narrowing towards the condenser to 1 foot 8 inches high, and 2 feet wide in the greater part of its course, again becoming larger and higher still, so as to form a small deposit chamber just before opening by two 12-inch square openings into the condenser. But between these two parts and about 6 feet from the condensers there are interposed two 12-inch pipes in order to permit of another underground flue crossing this flue. The condenser is here constructed of two chambers only, the first (in consequence of the length of flue) not being considered requisite. Both of the chambers contain perforated bricks; in other respects the condenser resembles that on the north side. The flue leading to the fire is very short, indeed the fireplaces are built in this case against the side of the condenser. The fireplaces are constructed as shown in the drawing, Plate 25. There are two of

them, and the flues are provided with dampers so as to direct the vapours to one or the other fire as may be desired. The object of having two fires is as a provision against one of them being accidentally extinguished by the vapours. The flue from the fires enters the bottom of the chimney shaft 100 feet high. I was informed that, in working this arrangement of duplicate dens, the flooring forming the roof of the den filled the day before is partially raised, and a cap is placed upon the opening of the pipe leading from it before the filling of the other den commences. I examined the two pipes, lower flues, and condensers in their whole length. There was very little deposit in the pipes leading from the dens. The tower was encrusted with siliceous deposit, of which there was a deposit 1 foot deep at the bottom. At a distance of about 30 feet from the tower the deposit was 6½ inches deep; in fact it came just up to the lower edge of the interposed pair of pipes. There was very little deposit in the short pair of interposed pipes, and very little again in the wide part of the flue near the condenser: but this part is cleaned out monthly. I was told that the tower and first 30 feet of the flue had not been opened for more than 12 months. The lower part of the condenser had not been opened for two years, and the appearance it presented differed in nothing from that of the condenser on the north side. There was no deposit whatever in the short length of flue leading from the condenser to the fire, and nothing but ordinary flue dust or soot in the flue leading from the fires to the chimney stack. This fact indicates sufficiently clearly that no condensable vapours had escaped the action of the scrubber. By an arrangement provided for the purpose, the whole of the products of combustion in the fires were made during a period of mixing to pass for a time through and out of a testing chimney shown in the drawing. They had no odour of manure vapours, nor any other odour than that ordinarily proceeding from the combustion of coal or coke.

In a letter from Mr. C. Burnard, dated April 10, he tells me that, although he found arsenic in the deposit within the flue leading from the dens to the condenser, he did not find the slightest traces in the flue stuff at the bottom of the chimney, *i.e.*, after the vapours had passed the condenser; and further, that during the mixing of the large den on Feb. 14 last, he caused the chimney gases to pass through a weak solution of hydrochloric acid for about four hours, and could not, by the most delicate tests, discover any presence of arsenic.

The efficiency of the arrangements at these works for collecting and condensing, or burning the vapours produced during mixing, and those evolved during the first few hours of retention of the manure in the den is thus, in my opinion, incontestible.

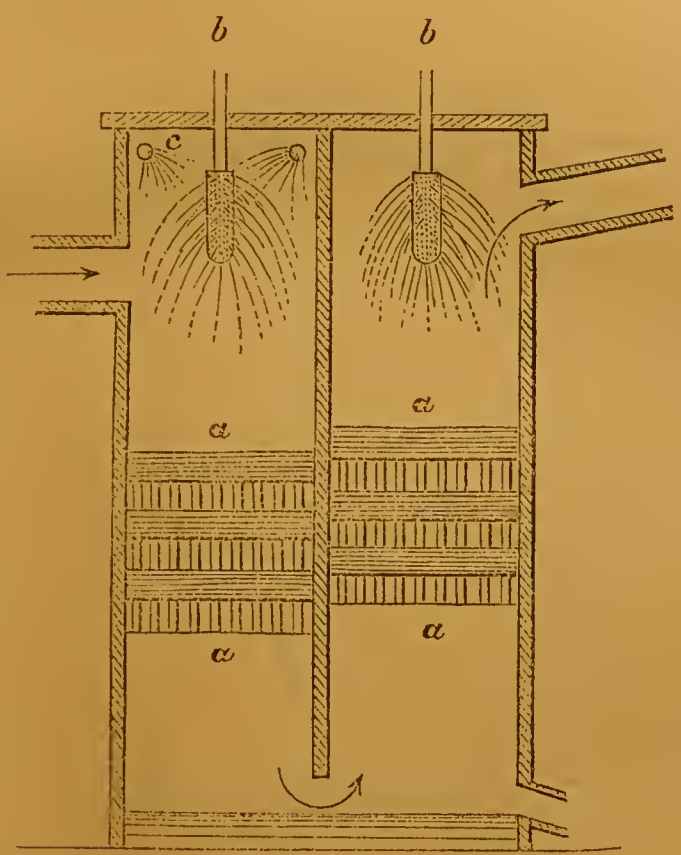
I have described the condensing arrangements at James Gibbs & Co.'s works. The remaining manure works at Plymouth are situated, close to Gibbs' works, at Cattedown, about a quarter of a mile beyond the works of Messrs. Burnard, Lack, and Alger, and outside the town.

At Norrington's works, Plymouth.

These works are known as Norrington's works. There are two sets of works, viz., a set at a lower and another at a higher level. The materials used are said to be phosphatic guanos, French and other mineral phosphates, and dry (foreign) bones. At the lower works there are two mixers of the ordinary construction fed through a valved hopper at the top, and each having a short shoot into a hot den well closed in during mixing. The period of mixing each charge (about 1 ton) is said to be from 5 to 10 minutes. Both from the mixer and the den a wooden flue, 2 feet 6 inches square, conducts the vapours to outside the works, where it is replaced by a stone flue of similar size. This leads to a condenser: the length of flue from the mixers to the condensers being

about 60 or 70 feet. From the condenser another flue passes up the side of the cliff, beneath which the works are situated, to a comparatively low chimney shaft on the top of the cliff: the distance from the condenser to the top of the shaft is said to be about 150 feet. The condenser is a closed brick tower about 15 feet high, about 10 feet long, and about 5 feet wide, divided vertically into two chambers. Each of them contains a series of wooden frames *a* made of deal planks set on edge, with intervals of about 3 inches between them. These frames are placed alternately, so that their vertical planes cross one another, and so that, on looking down the condenser, square channels appear to be formed all the way down. The following diagram (Fig. 6) is intended to show the kind of arrangement within the condenser; the arrows show the course of the vapours:—

Fig. 6.



Each condenser is supplied with water by a 1-inch pipe *b* passing through the middle of the roof, and terminated below by an elongated or cylindrical rose which is intended to throw out the water in a shower upon the wooden stages beneath. In addition, there is a perforated pipe *c* running round the top of the first chamber. The water flows into the pipes under some pressure being regulated by a tap in the general supply pipe. The spray thus produced was a fine spray, and in amount insufficient, in my opinion, to produce any considerable cooling or washing effect upon the vapours. Beside this, what struck me in the working of the rose was, that the spray of water did not fall downwards upon the wooden frames, but horizontally outwards against the sides of the brick chamber, along which the water flowed to the bottom, and then ran off. Really the only water which, so far as I could see, reached the middle of the framework was that which, in the first chamber, flowed from the pipe round the top, while the fumes from the flue entered below the level of the horizontal shower. Moreover, some of the perforations of the roses were choked up with rust or silica, and nothing flowed from them. Examining the arrangement during mixing time, I found vapours distinctly perceptible to sight and smell passing into the flue beyond the condenser. About 10 feet beyond the condenser, at a place where

the flue is capable of being uncovered for cleansing, I found a deposit of at least 6 inches in depth of siliceous matter, and the sides were incrusted with deposit, but to a much less extent. The manager told me that this part of the flue was cleansed about a year previously. In fact, the conclusion to be drawn is that, so far as the condenser is concerned, it exercises little influence upon the passage of the vapours, the chief protection to the neighbourhood being the length of flue. But even as respects this, however tardy the flow along the flue may be for the first 80 or 90 feet, it must be much more rapid from that spot to the top of the chimney shaft, since here the vapour flue is joined by the flue from the furnaces. The condensing arrangements at the upper works are similar, but here the flue from the mixer to the condenser is only 10 feet long, and the vapours after leaving the condenser pass with a very small interval into a chimney. There appears to me to be still less protection to the public against nuisance from this than from the lower part of the works.

c. Use of a fire.

c. When organic or nitrogenous matters enter into the composition of the manures, the offensive vapours proceeding from them in great part escape condensation either in the flue or by the action of water in a scrubber. It is therefore necessary in such cases, after such condensation as can be effected, to pass the vapours through a fire, so as to burn up any offensive organic matter they may contain. It is with this object that Burnard, Lack, and Alger superadded a fire to their condensing apparatus. The sugar scum they use gives to the manurial vapours, in addition to their acid pungent odour, a sweet smell of a somewhat ethereal character, and such as is objectionable to many persons, although not particularly so to myself. Where fish, excrement, blood, or garbage are used in the mixers, nothing but the best arrangements for combustion will deprive the vapours of their disgusting odour.

Relative value of flues and condensers.

Let me now endeavour to sum up the results of my observations on manure works, so far as they apply to the relative value of long flues and washers or scrubbers for arresting the escape of offensive vapours into the external atmosphere.

There is no doubt upon my mind that (except where offensive organic vapours are concerned) a sufficiently long flue, properly arranged and carefully managed may, under favourable circumstances of locality, constitute a full protection to the public against the nuisances proceeding from the process of mixing.* The flue is to be regarded as an elongated cooling chamber, affording facilities for the decomposition of the fluoride of silicon by the watery vapour present, and the deposition of condensed matters. But if the vapours pass through it too rapidly they may fail to be sufficiently cooled and condensed before arriving at the end of it. The flow of the vapours along it should be deliberate: and where the mixer is open, and hence where some motive force must be applied to draw or drive them along, the force should be just as much as will suffice to occasion a moderate in-draught to the mixer and no more. Hence I have been led to think that the use of a fan is sometimes, by causing too rapid a current in the flue, rather an injury to the condensation than otherwise: hence, too, when a chimney draught is used it ought to be judiciously regulated by a damper. Hence, again, the advantage of the baulks or mid-feathers introduced by Mr. Vickers into the first part of his flues: they retard the onward flow of the vapours, cause them to circulate to some extent in each part so divided off, and favour deposition. The interposition of wider and larger spaces, such as deposit towers or deposit chambers, through

* Dr. Dupré's experiments detailed in the Appendix to this Report fully confirm my inferences both with respect to the value of a long flue and of a water condenser or scrubber.

which the vapours may pass more slowly than through a comparatively narrow flue, also promotes the mutual reaction of the constituents of the vapours by the retardation they occasion. There are few works that I have seen in which, by the exercise of a little ingenuity, space might not be found for the adoption of this method. It is not at all requisite that the flue should be in one continuous line. It may be made to pass backwards and forwards, either under ground or above ground, with as many bends as may be requisite to obtain the necessary length; indeed, the more it is bent about the better for its efficiency, the draught being duly regulated. Where the mixer is thoroughly closed as at Burnard, Lack, and Alger's works, it is no bad plan to throw the vapour from the mixer into the den, which then becomes a first condensing or deposit chamber. It is impossible to say what should in all cases be the length of the flue. The determination of this must depend upon a variety of considerations, among not the least important of which is its capacity, the presence of condensing or deposit chambers, and the rapidity of the current through the flue. At Vicker's works in Widnes 440 feet are not found too great a length.

Neither is there any doubt in my mind that, when a great length of flue is considered unattainable or would be inconvenient to construct, a sufficient protection against nuisance from the vapours proceeding from the process of mixing may be found in a well-considered and well-arranged water condenser or scrubber. My experience of the condenser at Mr. Newton's works in South Bermondsey and of that in use at Burnard, Lack, and Alger's at Plymouth, has quite convinced me of this. Where there is a very abundant and unlimited supply of water, Newton's condenser is applicable, but where the supply is not so abundant, as, for example, where it is taken from a town supply, and has to be paid for by meter, Burnard, Lack, and Alger's condenser is much more economical and equally effective. In my visits to manure works I have frequently seen water condensers or scrubbers upon the premises, which in reality were little better than playthings, and quite useless for their supposed purpose. The principal faults with them have been that water has been used stingily, that they have been badly packed with coke or some other material that has become quite choked up with deposit, or that they have been allowed to become dilapidated from neglect and practically useless —even if a pretence of using them was made. When water is supplied by a rose the perforations after a time become rusted up or choked with silica, and the same thing often happens with the perforations of a colander above the condensing chamber, so that when I have had the water turned on I have seen only a few jets falling, where provision was supposed to be made for an abundant shower. In other works I have seen various fanciful devices for sprinkling water into the condensing chamber, the only possible use of which was to save expense while making a pretence of condensation. All such devices have been mere shams. The provision of a water condenser on the premises is no evidence that it is used, as was strikingly illustrated during a visit I paid to the Western Counties Manure Works at Tor Point.

The ordinary faults of condensers.

It has appeared to me that when economy of space is a consideration, advantage might be gained by carrying the vapours into a sufficiently large chamber filled with spray produced by causing water under considerable pressure to impinge upon a copper disc or upon several discs. I gathered this idea from observing the arrangements for cooling air supplied to the law courts at the Town Hall, Salford. A similar idea appears also to have occurred to the managers of Langdale's Manure Works at Newcastle-on-Tyne, but here it was attempted to spray the interior of a flue bent several turns upon itself

and, the space being too narrow, the attempt proved a failure. But the principle is one which, I hope, will yet be carried into effectual operation at these works.

Proctor and Ryland's arrangements.

But I have yet to mention the arrangements adopted at Proctor and Ryland's works in Birmingham, by which the vapours are dealt with as they arrive from a mixer, not worked by machinery but by hand. I have already, p. 146, described the chambers in which the mixing is effected. From the upper part of each chamber a wooden flue, 2 feet square, conducts the vapours a distance of several yards (varying in the case of the two chambers), to a small fan which drives them down a pipe which, at the bottom, dips about a foot into an underground tank of cold water, renewed from time to time. In this tank the solid matters (dirt and silica) are deposited. It also receives, as I have pointed out (p. 121), the waste steam from the boilers, &c., and the overflow runs into the drains. From this chamber the vapours, or so much of them as remain uncondensed, are conducted into a fire. The arrangement is figured in Plate 16. I can say nothing as to its efficiency—mixing was not proceeding on the day that I visited the works.

4. From removal of manure from hot den.

4. The nuisance arising from the removal of the manure from the den is one of the chief of those now proceeding from manure works. But it is, at the same time, the nuisance which it is most difficult to find a remedy for. I protest, however, against any assertion that there is no practicable remedy. It is very difficult to find a practicable remedy, but cannot be impossible. To say this would be to ignore general experience in respect of many kinds of offensive businesses, as to which the same thing might have been said formerly, but cannot be said now. The discovery and application of a remedy is only a question of time, experiment, and cost. Only it is essential that the costliness of the remedy should not be excessive. Let us see, then, what is wanted. The nuisance arises from the emission from the hot manure of similar vapours to those which proceed from the mixer during the mixing process. The free space above the hot manure is full of them, and similar vapours are mechanically pent up in the mass of consolidated manure, and come off when the mass is broken up ; on the opening of the den they pass at once into the atmosphere, through the windows or doors of the den, or first into the building and then through its various openings into the outside atmosphere. In addition to such a prolongation of the mixing in the "mixer" (when practicable) as shall bring about the evolution of the major part of the vapours capable of formation where they can readily be conducted away and dealt with (one method no doubt of reducing the nuisance more or less, according to circumstances), two kinds of remedy may be suggested: either the manure may be left to become cold in the den, and thus the vapours in the den and those mechanically imprisoned in the manure to become so condensed as not to be evolved in any considerable volume on disturbing the manure; or the vapours may be permitted to escape into the building and be drawn off from it, and dealt with in an appropriate manner. These two suggestions must be considered separately.

Suggested remedies.

a. Suggestions for promoting cooling of manure.

a. The former of these suggested methods is the more difficult to carry into effect, for the reason that, although some manures consolidate quickly, all kinds cool slowly ; many days, as I have shown above, must elapse (under the most favourable conditions) before the manure becomes cold enough to be removed without emitting a good deal of offensive vapour. If this, then, were insisted on, it would involve great inconvenience and loss to the manufacturers at the busy season of the year, at least under present arrangements. Few works have more than one mixer, and still fewer more than two, and there is usually only one den

associated with each mixer, occasionally there are two, but I have rarely seen more than two. Hence with two mixers, each with two dens, one den of the four being filled daily, only two full days could be given for cooling in each den, since on the third day it would have to be emptied for refilling on the fourth, and this would still leave the manure too hot. But there are few works so favourably circumstanced as this. I have had many conversations with large manufacturers as to modes in which this difficulty might be met. Looking at the matter with an unpractical eye it might be said that a remedy might be found in increasing to the necessary amount the number of dens and mixers. Of course this would be a remedy, but it would involve the devotion of very much more space than can be spared, even in the largest works, where room is wanted for storage, both of materials and also of made manures, which (although it may be made all the year round to meet the requirements of a large trade) is for the most part only sold off at one period of the year. This, then, is an impracticable remedy. Again, it may be said that, instead of having only two dens associated with each mixer, there might be, say, four, the mixer being so placed as that the manure shall be discharged into each in succession ; but to this the same objection as to the space requisite for such an arrangement might be made. Another mode of meeting the difficulty would be the adoption of means to expedite the cooling of the manure. One mode of doing this suggested itself to my mind on observing that at some works a very large area was provided for the floor of the den, and that it was only filled to the height (nearly uniformly) of about four feet; while in other works, where the area was small, the manure lay upon it to the height of 10 or 12 feet. A quantity of manure lying only 4 feet in depth cools far more rapidly than a quantity lying 10 or 12 feet in depth. When suggesting this to Mr. Burnard he said that, while the remedy would be very applicable to some kinds of manures it would not be applicable to others, since it presupposed that all manures would flow with equal readiness when discharged fresh into the den, and would set with equal rapidity, and this is not the case. Besides, he pointed out that the action of the acid continues after the discharge of the manure into the den and that in many cases it is desired that it should continue; but to enable the action of the acid to continue, the temperature must be maintained, and the manure must not be allowed to become prematurely chilled as it would be, especially at a distance from the place of entrance, if allowed to spread itself out in a thin layer. Probably this last objection does not apply to all kinds of manure, but it does to some. Mr. Burnard has since written to me thus : " When working with materials containing much " iron, I am informed by Mr. Packard, who has had much experience in " working German phosphorites, that the den should be so constructed " as to allow the manure to run out thin, so as to cool very quickly. This " method of working them prevents, or rather lessens to a considerable " extent, the combination of the iron, lime, and phosphoric acid, so " that the superphosphate does not go back in its per-centage of soluble " matter." Mr. Burnard adds, "In working with Cambridge and some " other coprolites whose 'setting' power is good, depth is not essential; " but in our experience, with the materials we have been accustomed " to use, we find depth essential ; in fact, the nearer we can come to a " cube, less the corners, the better. When the liquid manure has to " flow far, the thinner parts (containing excess of acid) run off from " the thicker and undissolved parts, so that the mass is not uniform. " This separation is especially likely to take place and to be incon- " venient when bones are used, since they mostly remain under the shoot, " whereas they ought to be distributed equably so as to give them a

"fair chance of softening and becoming incipiently dissolved." In estimating the value of these observations of Mr. Burnard, it is to be kept in mind that he regards the "mixer" merely as a mixer, as merely the place where the action is initiated; and looks to the den as doing the greater part of the work. The objection to the manure being allowed to form a thin layer would apparently be less in works where (similar materials being used) the mixing in the "mixer" is prolonged to pastiness. My conversation with Mr. Burnard then turned upon the practicability of drawing off the vapours from the den prior to and during the whole process of removal, and he told me that he was himself about to try to effect this and showed me an apparatus (Körting's blower) which he was about to put up with the view of driving all these vapours through his condenser instead of allowing them to issue into the building. He has since informed me that the attempt has at present issued in failure, but that he intends to try again.

b. Drawing off of liberated vapours.

b. The latter of the suggested methods of meeting the hot den difficulty, namely, permitting the vapours to escape freely into the building, and then drawing them off, is not only practicable, but may be seen in operation at Hunt's works at Bow Bridge. I have twice already referred to these works, and the successful manner in which the manure and bone boiling nuisances have been grappled with (pp. 119 and 162). At these works all the vapours from the mixer, and from the whole interior of the buildings, which are virtually close buildings, are drawn off through appropriate flues by means of a powerful fan, which drives them first through a washer, and then through a fire. Nothing offensive escapes externally. If it should be argued that some manure buildings are to extensive to be thus dealt with, the reply is that it is quite practicable to partition off the largest building into chambers, each of which might if necessary be separately dealt with. Of course such a practice as that which I have described (p. 155) as followed at Norrington's works at Plymouth, should not, in the vicinity of a town, be tolerated for a day.

5. From general offensive odour from works.

5. The general offensive smell from manure works, which is not immediately dependent upon the processes of mixing and removal of the hot manure, may be similarly obviated by ventilating all parts of the interior of the building where manure is stored or manipulated into a tall chimney shaft by means of a fan. Advantage would also be gained by the periodical renewal of the inner surfaces of the building by means of a layer of lime wash, and by the observance of cleanliness generally. I am satisfied that manure making might, with a little extra trouble, be carried on in a much more cleanly and less slovenly manner than is observable in most of the works I have visited. The drying of scutch manure by spontaneous heating should be carried on only with the precautions suggested for similar spontaneous drying of boiled bones (p. 121). Kiln drying, or drying upon flues, should not be carried on upon open kilns. The kilns should be situated in a building of some sort, from which the vapours should be drawn off and conducted through a fire. No great ingenuity need be exercised in effecting this.

Avoidance of nuisances in poudrette making.

The means adopted at Bilston by the Towns Manure Company for preventing nuisances during the manufacture of poudrette from night-soil were, at the time when I visited the works, as follows:—The whole of the process, from the reception of the night-soil in covered vessels to the packing of the poudrette in bags, was conducted within a closed building. The night-soil, immediately the sulphuric acid was added to it, was emptied into one of Milburn's patent desiccators (30th July 1872, No. 2,266). The interior of the machine communicated with a Baker's blower, which sufficed to create a sufficient in-draught to prevent any

escape of offensive effluvia through the crevices of the cover, or when the cover was partially removed for the purpose of charging the machine. By means of a special arrangement of flues, this blower drove the vapours given off through two fires used for heating the drying floor, and the products were discharged from a chimney shaft 128 feet in height. As the furnaces were arranged at these works, an occasional escape of unconsumed vapour might take place if the stoker was not very careful in the manner of coaling, and in the management of the dampers. But on the whole the plan adopted was successful in preventing nuisance. I have not had an opportunity of seeing the method of drying excrement adopted by Captain Liernur at Dortrecht, but it has been very carefully elaborated, and is said to be unproductive of nuisance.

June 1877. EDWARD BALLARD.

APPENDIX.

PRELIMINARY REPORT on the GASES EVOLVED during the MANUFACTURE of SUPERPHOSPHATE from CAROLINA PHOSPHATE at the Works of JAMES GIBBS & Co., Victoria Docks.

THE superphosphate is prepared by the action of slightly diluted sulphuric acid on finely powdered Carolina phosphate. The mixing of these two is effected in a covered mixer, having a long narrow aperture at the top, through which the powdered phosphate is introduced. This tank communicates with a long wooden flue or shoot, at the farther end of which a fan is worked, drawing a strong current of air through the tank into the shoot and forcing it through a scrubber into a chimney. All gases and vapours evolved during the mixing are thus swept into the shoot, and can only escape into the chimney after having passed the scrubber. About 5,000 cubic feet of air are thus passed through the mixer and flues per minute. The phosphate and the acid are introduced into the mixer in quantities of 12 cwt. of the former to 8 cwt. of the latter, with the addition of about 3 cwt. of water. The thorough mixing is effected by means of a mechanical stirrer, which also helps in emptying the tank and takes a few minutes only. During the mixing the temperature is greatly raised; but while actually in the tank a small portion only even of the carbonic acid escapes, as the mixture has to be run off into a large "den" beneath before much effervescence takes place, otherwise the mixture overflows from the tank. No doubt the greater portion of the carbonic acid, as well as of the tetrafluoride of silicon liberated, escapes gradually while the mixture is in this "den."

I endeavoured to examine the gases evolved by passing pipes into the shoot,—

1st. As near as possible to the mixer (point I.);

2nd. Into the shoot just before it enters the scrubber (point II.);

3rd. After having passed the scrubber (point III.);

and by drawing the gases from these points by means of small steam exhausts through gutta-percha bottles containing a solution of pure caustic soda, which would absorb the gases sought for, and could afterwards be examined for them. No definite result was, however, arrived at, not only on account of the enormous quantity of air passing through the shoot greatly diluting the gases, but also on account of the silica separated from the tetrafluoride stopping up the pipes of the apparatus. For these reasons I have been unable to come to any definite conclusion as to the existence or non-existence of free hydrofluoric acid in the gases evolved, and must reserve the final decision on this point for a future occasion. The following points, however, have been proved:—

1st. That the gases, after having passed the scrubber, contain no appreciable traces of any fluorine compound, but still contain minute traces of arsenic.

2nd. That the proportion of fluorine compounds evolved is only a small fraction of the amount of carbonic acid liberated (which in the mean of two experiments amounts to about 2 % of the volume of air passing through the shoot), probably less than 1/30th part. [The alkali through which the gases from point I. had been passed contained 96 % of carbonate of sodium, the remainder consisting of fluoride of sodium, silica, chloride of sodium, traces of arsenic, &c., &c. The solution from point II. contained 98 % of carbonate of sodium; that from point III. and upwards of 99 %.]

3rd. That the gases evolved contain small but distinct traces of arsenic; much of this, however, is stopped by the scrubber.

There are, however, some facts observed which render it at least highly probable that no free hydrofluoric acid is present in the gases evolved.

a. The phosphate employed contains a very large excess of silica compared to the amount of fluorine present, and it is not likely that hydrofluoric acid would be evolved under such circumstances. Two samples of Carolina phosphate used at the works of Messrs. James Gibbs & Co., were found to contain :—

	Sample 1.	Sample 2.*
Carbonic acid	4·32	4·28
Fluorine	1·81	1·90
Silica	——	12·00

Much of this fluorine, moreover, remains in the resultant super-phosphate, and the ratio between the amount of silica present and fluorine evolved is even much greater than these analyses indicate. Thus the manure made during my visit from sample 2 was found on subsequent examination to contain—

Fluorine	0·86 %
Silica	6·65 %

And as one part of phosphate yields about 1·75 part of superphosphate, it follows that the proportions of fluorine and silica left in 100 parts of original phosphate amount to—

Fluorine	1·50 %
Silica	11·64 %

showing at all events that by far the greater proportion of fluorine is left in the superphosphate. The same seems to be the case with regard to the arsenic contained in the sulphuric acid used, the greater part of which remains in the superphosphate under circumstances similar to those of these works.

b. It is highly improbable that in a mixture of tetrafluoride of silicon, hydrofluoric acid and steam, silica would be deposited as long as any hydrofluoric acid is present. The deposition of silica thereof shows, I think, that at that point no hydrofluoric acid is present. Now, the deposition of silica begins at once, or almost at once; and as, owing no doubt to an insufficiency of watery vapour and the comparative shortness of the flue at these works, only a small proportion of the total amount of tetrafluoride evolved is decomposed in the shoot, the far greater part reaching the scrubber to be there decomposed, the amount of hydrofluoric acid contained in the gases evolved can be but a small fraction of that of the tetrafluoride, otherwise no deposition of silica would take place at the near end of the shoot.

During the passage of the gases and steam along the shoot a variety of reactions probably take place. A portion of the fluosilicic acid produced is again evaporated, and thereby split up into tetrafluoride and hydrofluoric acid; this in turn acts on the silica separated, once more forming tetrafluoride to be again decomposed, &c., &c. It is thus possible that traces of hydrofluoric acid may be found in parts of the shoot; and the etching effect on glass which the gases evolved produce, is no doubt mainly due to this evaporation and consequent decomposition of hydrofluosilicic acid.

As the case stands, we are thus, I believe, justified in concluding—

---

* This sample was taken from the material used during my visit to the works.

1st. That by far the greater portion, if not all, of the fluorine evolved during the process of manufacture of superphosphate from Carolina phosphate, is evolved in the form of tetrafluoride. If no efficient scrubber is used this tetrafluoride would escape into the air and be converted gradually into fluosilicic acid and silica. The fluosilicic acid in its turn may, whenever it is condensed and again evaporated, produce free hydrofluoric acid. If, however, an efficient scrubber is employed, the whole of the fluorine compounds are arrested.

2nd. The gases evolved when certain kinds of sulphuric acid are used contain distinct traces of arsenic, not all of which is arrested by the scrubber, but escapes in part into the air.

3rd. The superphosphate produced contains the greater part of the fluorine present in the phosphate employed, as well as the greater part of the arsenic contained in the sulphuric acid used.

(Signed) A. Dupré.

Westminster Hospital,
June 30th, 1877.

Further Report on the Gases Given Off in the Manufacture of Superphosphate from Carolina Phosphate, at the Works of Messrs. James Gibbs & Co.

In a previous report, dated June 30th, 1877, the method of manufacture adopted at these works, as well as the general character of the gases evolved during manufacture, was described. It was there shown that, in all probability, all the fluorine evolved during the process was given off as tetrafluoride of silicon. The apparatus then employed in the collection of the gases did not, however, enable me to settle the question definitely, and I have therefore again visited the works with a more efficient form of apparatus, with which I have obtained much more definite results. Before describing these, the following additional details connected with the manufacture may be mentioned.

As before explained, the powdered phosphate, sulphuric acid, and water, are introduced into a mixer in the proportions of 12 cwt., 8 cwt., and 3 cwt. respectively. They are thoroughly mixed by a mechanical stirrer, and run into a den, before any considerable evolution of gas has taken place. During this mixing the temperature of the mass rises considerably, up to 160 or even 186° F., according to the length of time it is kept in the mixer. Usually the temperature in the mixer ranges between 120 and 160° F. only, but goes on rising somewhat in the den, in which the temperature of the mass, when about 30 tons had been run in, was found to be 180° F. The temperature in the shoot, close to mixer and den, both of which are ventilated into the shoot, stood at 80° F. shortly after the mixing had begun, but as more and more of the hot mixture accumulated in the den the temperature gradually rose to 125° F.

The air in the shoot was found to be perfectly saturated with moisture, even at the elevated temperature, and there can therefore be no question that much more than sufficient water is present to decompose all the tetrafluoride that could possibly be contained in the gases evolved. But to return to the experiments.

A lead pipe ($\frac{5}{8}$-in. diam.) was passed into the shoot close to the entrance of the flues from the mixer and den. Through this pipe a portion of the gases, &c., &c., passing through the shoot was drawn by means of a small steam exhaust, and forced, together with this steam, into a lead condenser kept cold by water. In this condenser the steam from the jet, as well as that present in the air, is condensed, and any tetrafluoride of silicon present is decomposed into silica and fluosilicic acid, the latter dissolving in the condensed water. Any hydrofluoric acid present would simply be dissolved. In case no hydrofluoric acid is present the condensed liquid would contain silicon and fluorine in the proportion of 1 equivalent or

28 parts of the former, to 6 equivalents or 114 parts of the latter. If, however, hydrofluoric acid as well is present in the gases the proportion of fluorine would be found higher. The acid liquid as it ran from the condenser was at once filtered, to prevent, as far as possible, all action between the silica separated and any hydrofluoric acid that might be present. The liquid was also collected in two portions, the first portions between the hours of 1 p.m. and 2.30 p.m. (the mixing having begun at 1), the second between 2.30 and 4 p.m. While the pipe between shoot and condenser was clear (occasionally it had to be cleared) about 50 cubic feet of air passed through the condenser per minute, which, though only a small portion of the amount of air passing through the shoot (about 5,000 cubic feet per minute), was yet sufficient to yield an amount of acid readily allowing the quantitative estimation of the fluorine and silica contained in it. These were found to be the following :—

	Silicon.	Fluorine.
In the first portion - -	0·081 %	0·32 %
In the second portion - -	0·091 %	0·35 %

The proportion of silicon found is thus a little higher than it should be on the assumption that all the fluorine is present as fluosilicic acid when it should have been 0·079 % and 0·086 % respectively. The small excess found is no doubt due to the fact that the freshly separated silica is slightly soluble in the condensed liquid. It is thus clear that all the fluorine contained in the gases evolved is present in the form of tetrafluoride, and no portion of it in the form of hydrofluoric acid.

When the mixing begins the temperature of the shoot is comparatively low, and much moisture, containing hydrofluosilicic acid in solution, will be condensed even in the first portions of the shoot. As the temperature rises some of this will again be volatilized; but as this volatilization takes place in contact with a large excess of finely-divided silica (deposited in the shoot) tetrafluoride of silicon only will be produced. This in its turn is again decomposed, in the cooler parts of the shoot, into silica and fluosilicic acid. If then the shoot is of sufficient length to allow the gases to become cool, all the tetrafluoride will be completely decomposed into silica, which is deposited in the shoot, and into fluosilicic acid which remains dissolved in the water condensed, and no irritating gases will escape into the air. In case the shoot is short it will have to be supplemented (as it is in the works of Messrs. Gibbs & Co.) by an efficient scrubber. Taking then this and the former investigation together we arrive at the following conclusions :—

1st. All the fluorine evolved during the process of manufacture of superphosphate from Carolina phosphate is evolved in the form of tetrafluoride.

2nd. By the employment of a sufficiently long shoot, or a short shoot and a scrubber, all the tetrafluoride can be arrested.

3rd. The gases evolved, when certain kinds of sulphuric acid are used, contain distinct traces of arsenical compounds, not all of which are arrested by the scrubber.

4th. The superphosphate produced contains the greater part of the fluorine that was present in the phosphate employed, as well as the greater portion of the arsenic contained in the sulphuric acid used.

(Signed) A. Dupré.

Westminster Hospital,
Sept. 25th, 1877.

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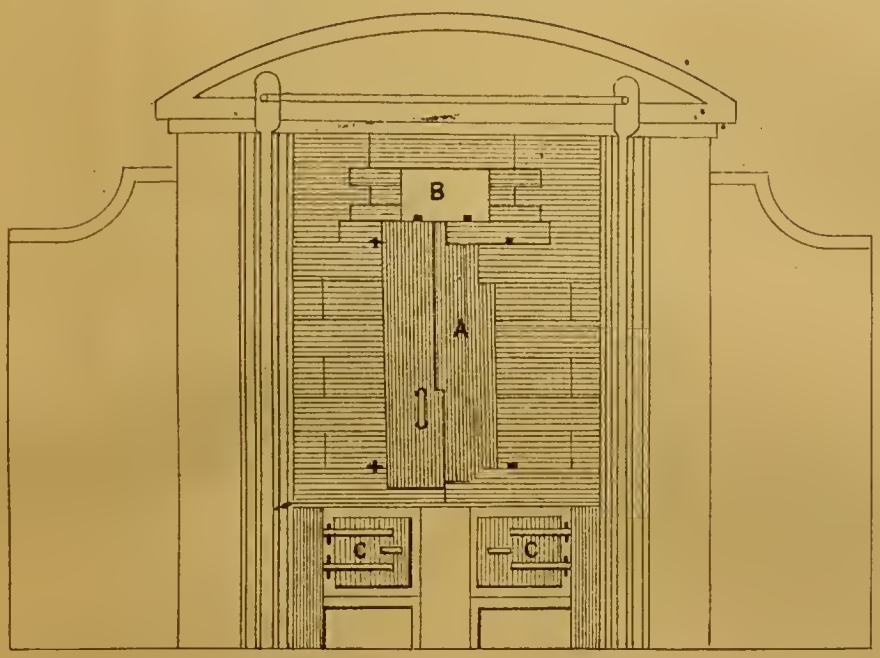
For Her Majesty's Stationery Office.
[22002. 750.—4/82.]

A & E. M. DENNY'S PATENT PIG-SINGEING FURNACE AND APPARATUS.

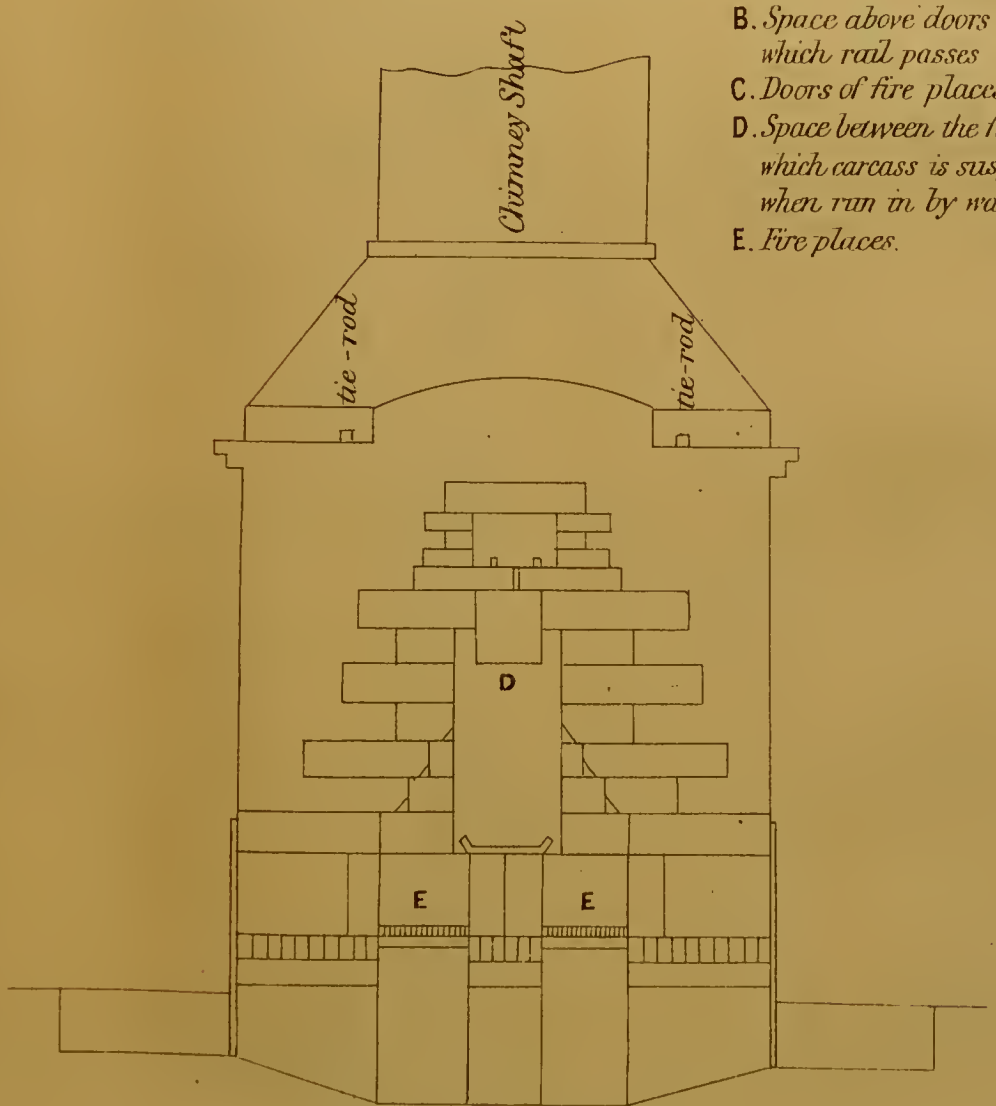
Scale of Feet

12 0 1 5 10



FRONT ELEVATION.

A. *Pair of iron doors*
B. *Space above doors through which rail passes*
C. *Doors of fire places*
D. *Space between the fires in which carcass is suspended when run in by waggon.*
E. *Fire places.*



TRANSVERSE SECTION.

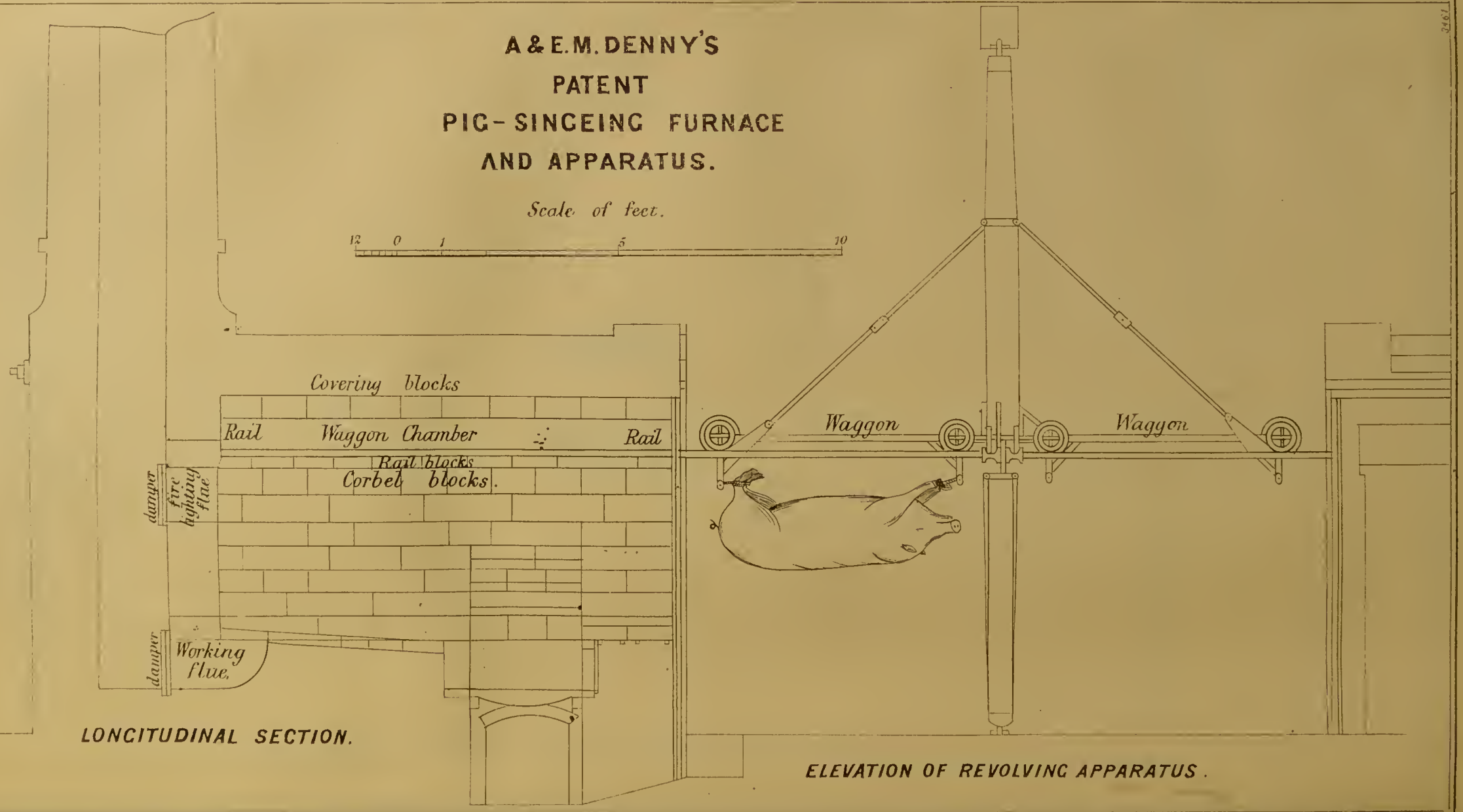
3461

Plate 2.

A & E.M. DENNY'S PATENT PIG-SINGEING FURNACE AND APPARATUS.

Scale of feet.

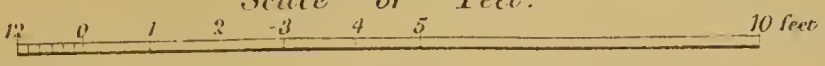
12 0 1 5 10

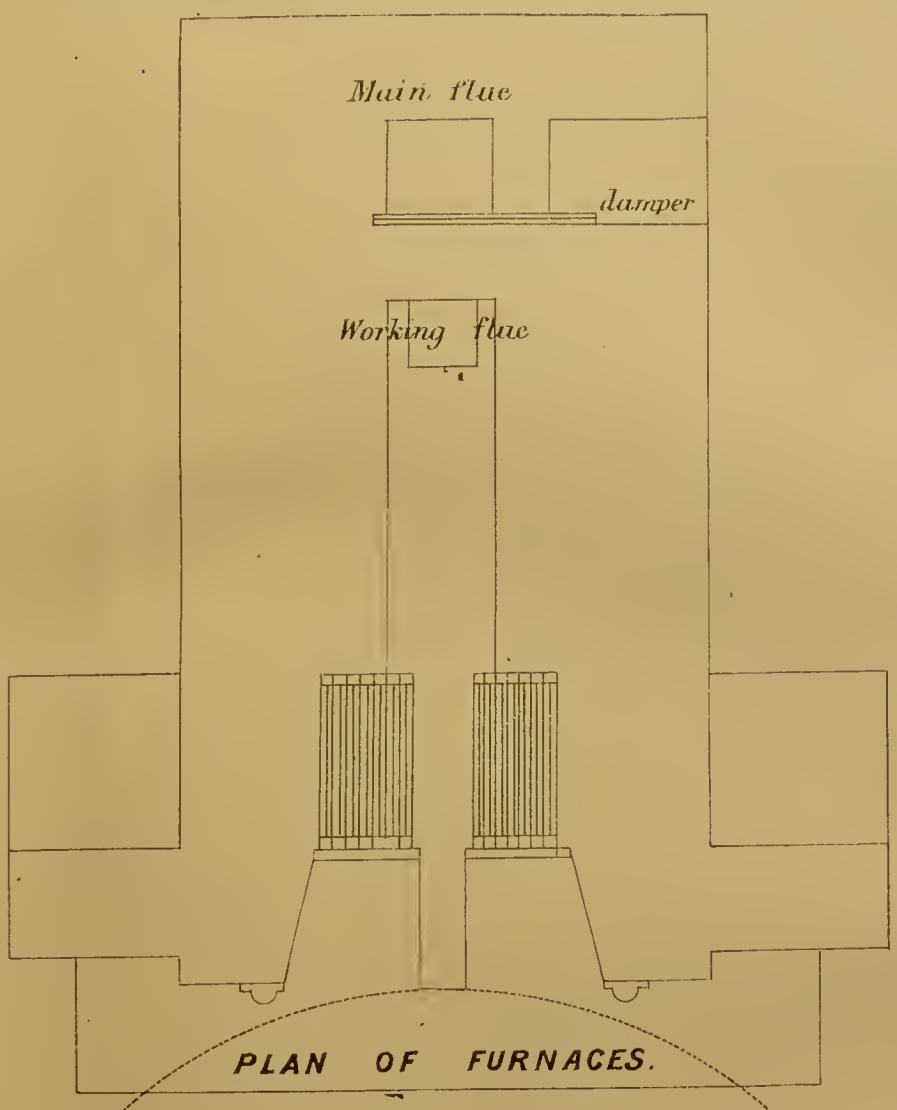


LONCITUDINAL SECTION.

ELEVATION OF REVOLVING APPARATUS.

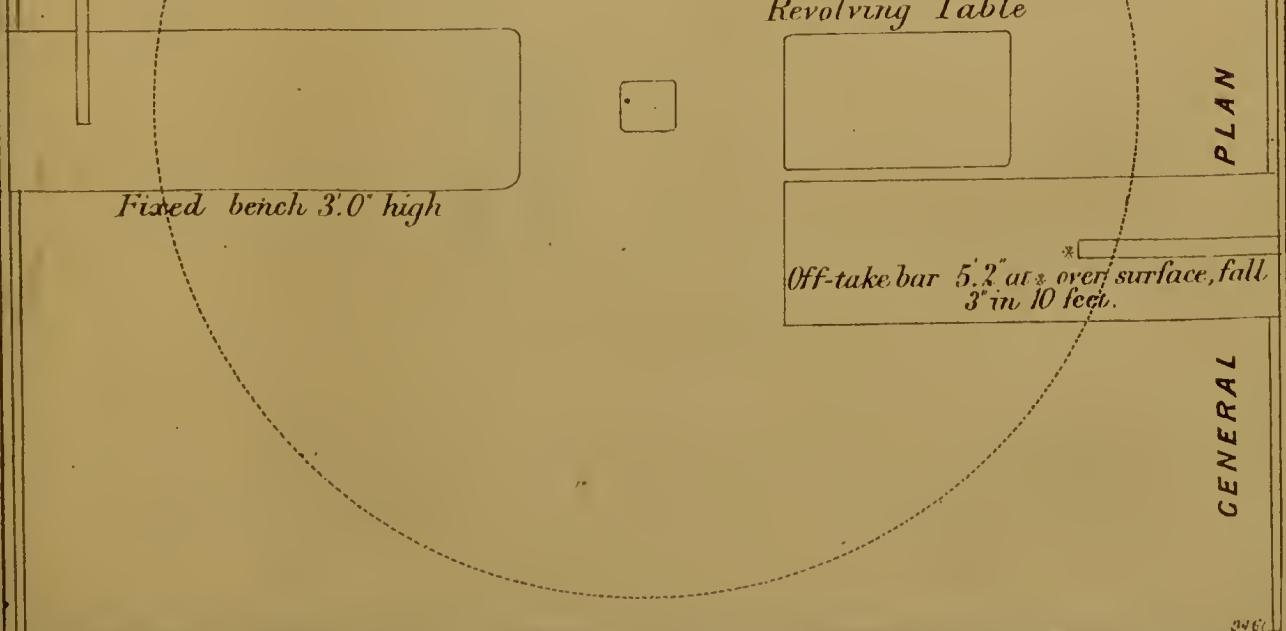
A. & E. M. DENNY'S
PATENT
PIC-SINGEING FURNACE AND APPARATUS.





PLAN OF FURNACES.

Bar from Killing Sty. Clear height from Surface, 7.8" fall 3" in 10 feet.



PLAN OF ARRANGEMENT OF DOUBLE FURNACES.

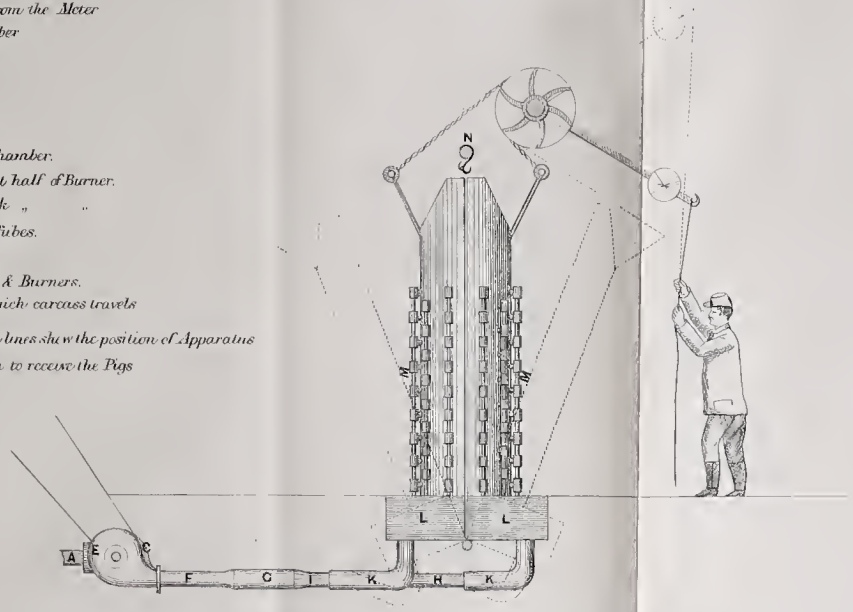
GENERAL

PIG SINGEING APPARATUS USED BY MR DOLE, BRISTOL.

Scale, 3/8 inch to a foot.

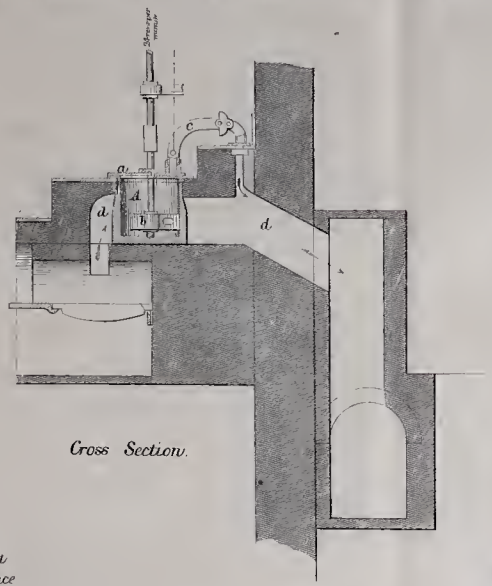
A. *Gas Pipe from the Meter*
B. *Gas Chamber*
C. *Gas Fan*
D *Gas Pipe*
E. *Air Fan*.
F. *Air Pipe*.
G *Mixing Chamber*.
H *Pipe to front half of Burner*.
I „ *back* „ „
K. *Flexible Tubes*.
L. *Receivers*.
M *Gas Pipes & Burners*.
N *Rod on which carcass travels*

The dotted lines shew the position of Apparatus when open to receive the Pigs

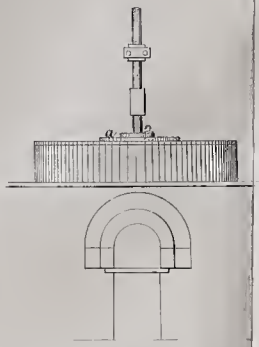


DANGERFIELD LITH 22 BE

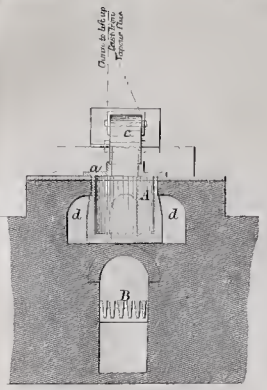
Plan shewing arrangement of the Pots, Stirrers, Covers, Flues &c. at Sir E. Buckley's Prussiate of Potash Works. Clayton. Manchester.



Cross Section.



Front Elevation.

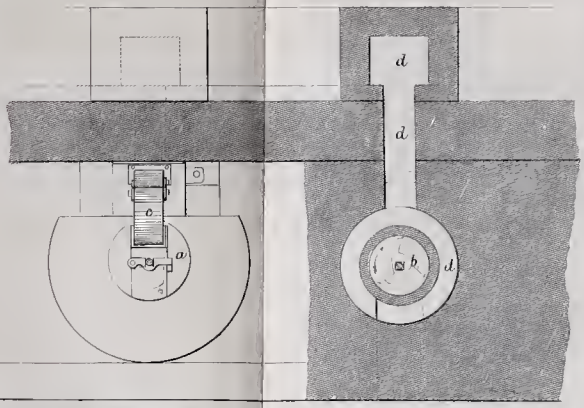


Vertical Section

A. Iron pot
B. Fire place
a. Cover of pot
b. Stirrer
c. Hinged pipe conveying vapours to the flue
d. Flue surrounding the pot & leading to the chimney shaft.

Scale.

ft. 0 0 1 2 3 4 5 10 feet



Ground Plan. Sectional Plan.

3460

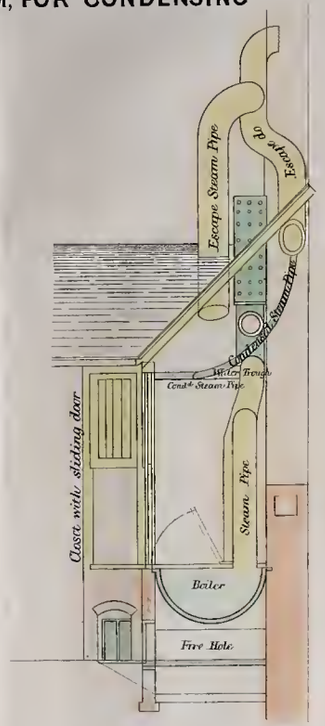
Daugerfield. Lith 22 Bedford St Covent Garden

PLAN OF ARRANGEMENT IN USE AT Mr ADAMS' KNACKERY, BIRMINGHAM, FOR CONDENSING AND CARRYING OFF THE VAPOURS FROM BOILING PANS.

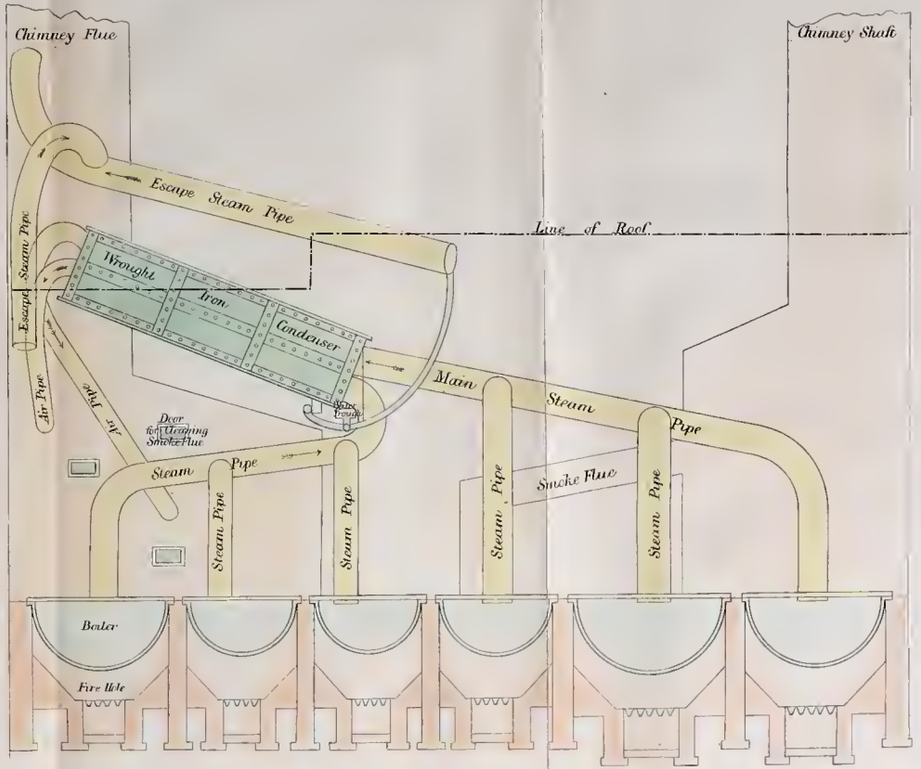
PLAN.

5 0 5 10 20

Scale of Feet.



SECTION ON LINE C.D.



SECTION ON LINE A.B.

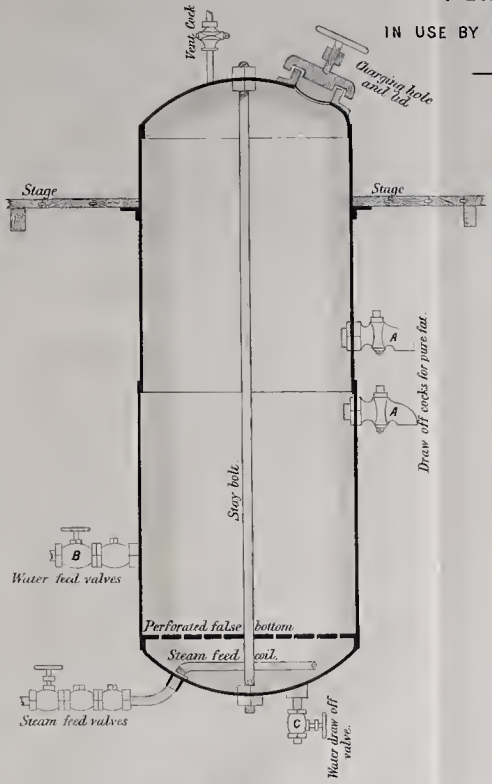
3367.

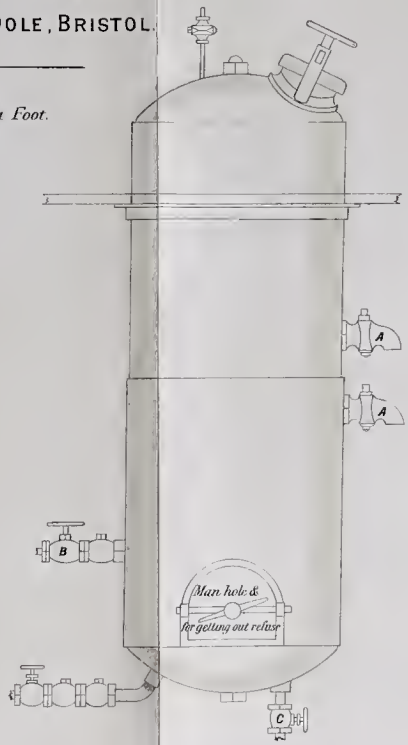
Dangerfield Lith 22 Bedford St Covent Garden

Plan of Digester

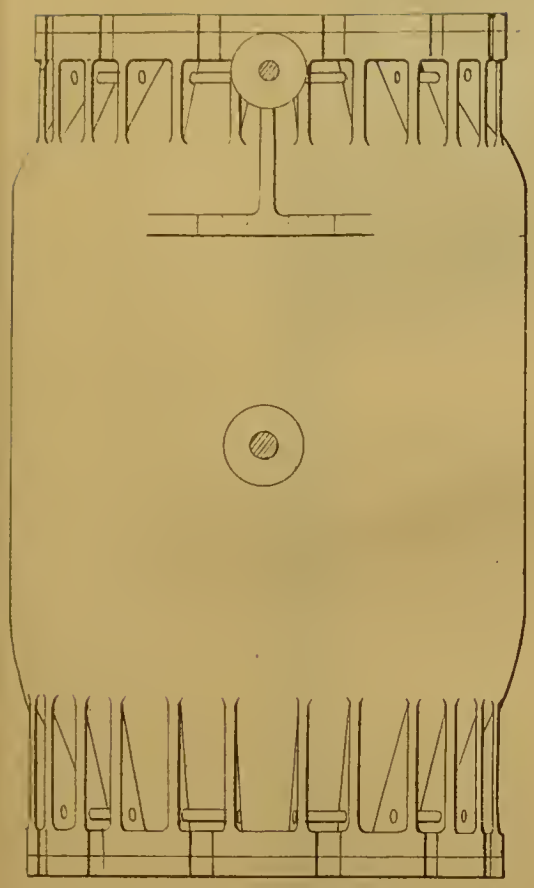
in use by Mr. James Dole, Bristol.

Scale, ¾ Inch to a Foot.

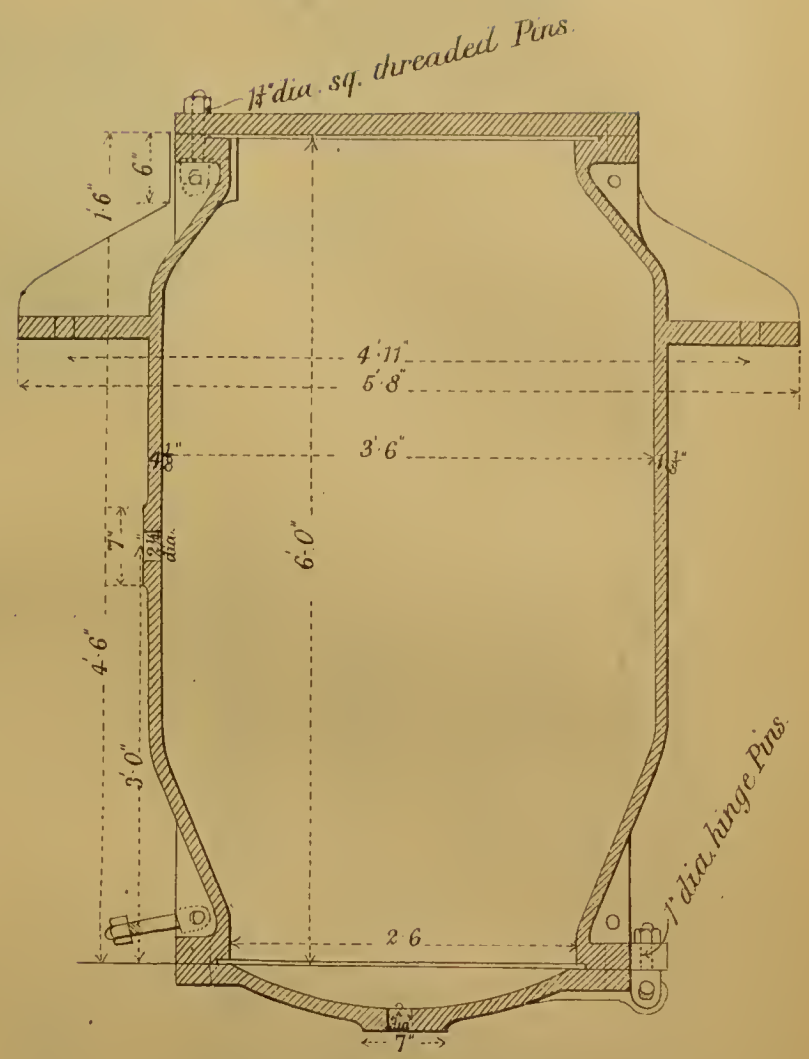




Dangerfield, Lith 22, Bedford St Covent Garden 1865



FRONT ELEVATION.



VERTICAL SECTION.

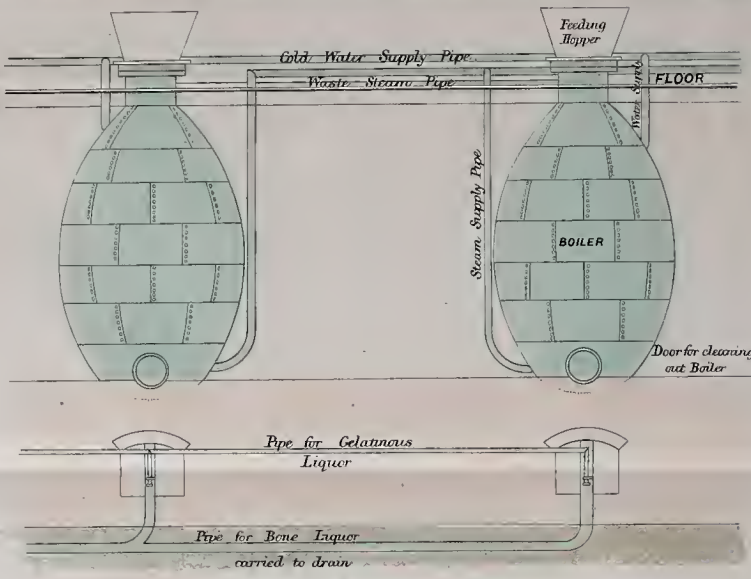
PLAN.

BOILER

FOR

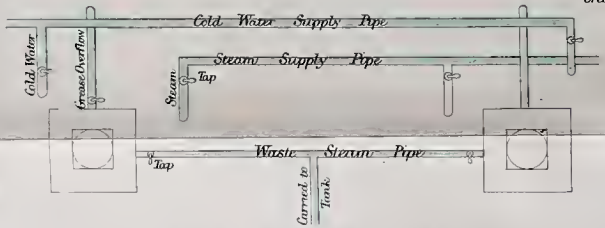
FULLER'S PATENT PROCESS.

Scale ½ Inch to the Foot.

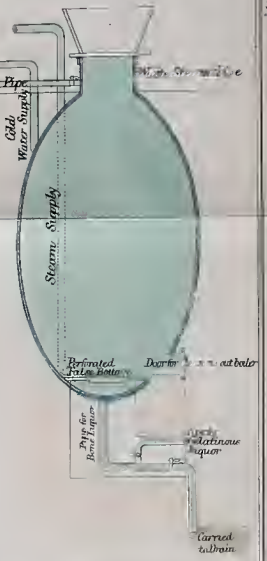


FRONT ELEVATION.

SECTION THROUGH BOILER.



PLAN ABOVE BOILERS.



SKETCH OF BONE BOILING APPARATUS

USED BY MESSRS. PROCTOR AND RYLAND OF BIRMINGHAM.

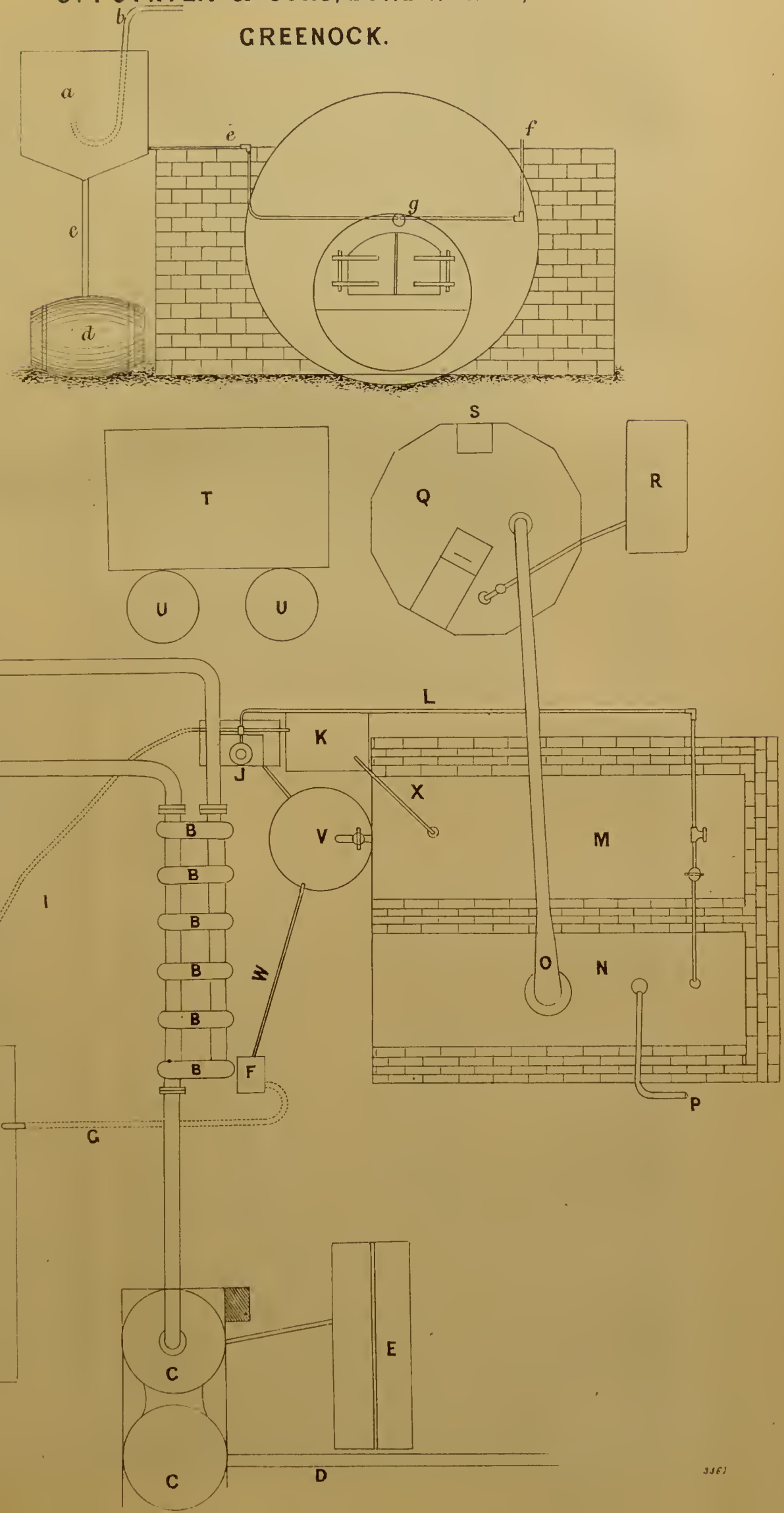
Scale; 8 Feet to an Inch.

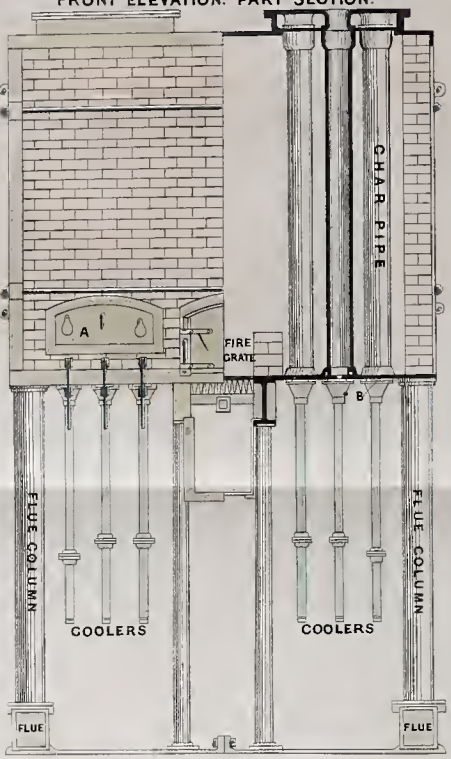
Plate 9.

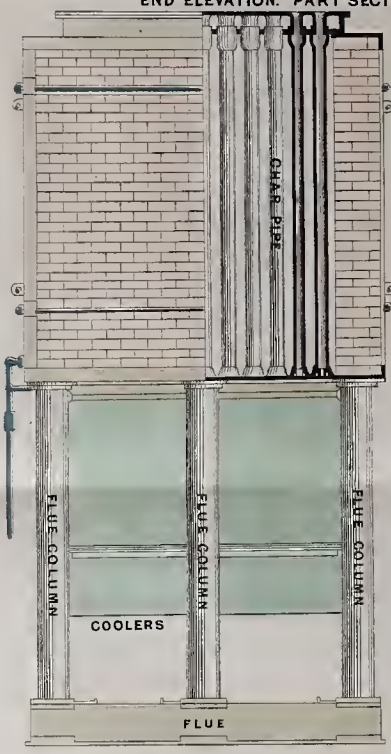
DANCERFIELD LITH 22 BEDFORD ST COVENT GARDEN

Plate 10.

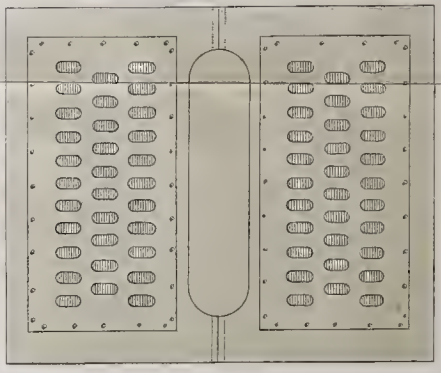
PLAN OF APPARATUS IN USE AT J. POYNTER & SONS, BONE WORKS, GREENOCK.







PLAN
TOP OF KILN.



Plan of Pipe Kiln for Reburning Animal Charcoal.

Scale 1/8 inch to 1 foot.

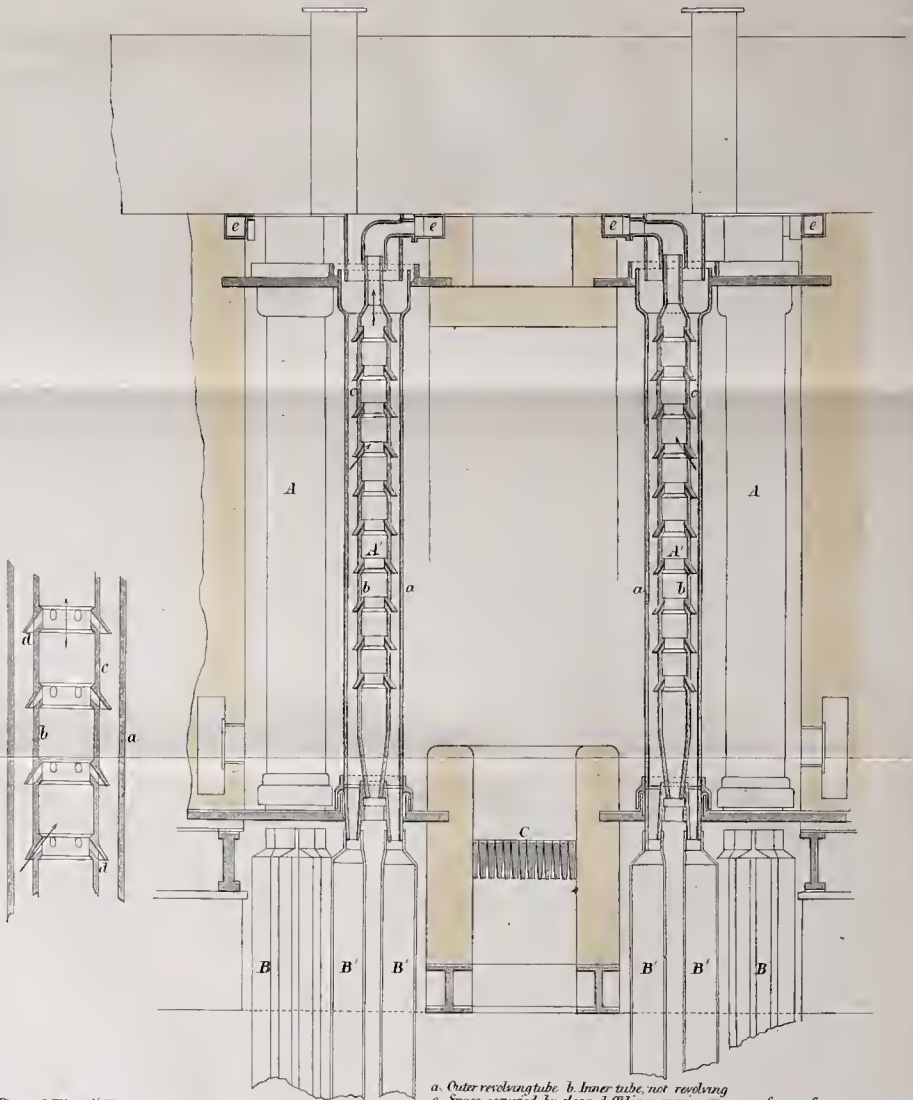
Plate II.

3467

Dangerfield, Lith. 22 Bedford St. Covent Garden

Buchanan & Vickess' Patent Kilns.

Scale ½ in. = 1 foot.



A. Pipes of Kiln. *A'* The same in vertical section.
B. Coolers which revolve. *B'* The same in vertical section.
C Fire place.

a. Outer revolving tube. *b.* Inner tube, not revolving.
c. Space occupied by clear. *d* Oblique openings in circumference of inner tube. *e.* Flue with which inner tube communicates.
course of vapour indicated by the arrows ⟶

Plate 12.

3459

Plate 13.

J. F. BRINCES PATENT

APPARATUS FOR RE-BURNING ANIMAL CHARCOAL

Fig 1.

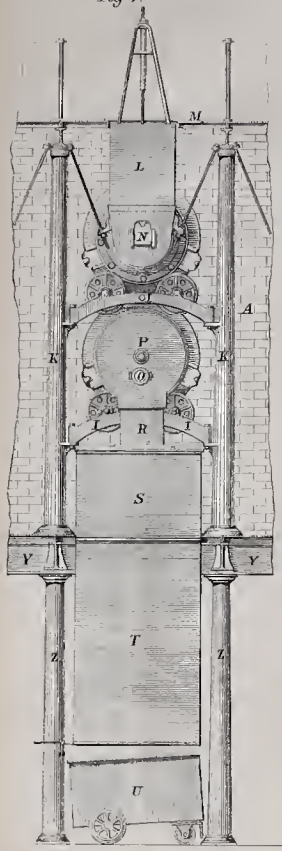


Fig 2.

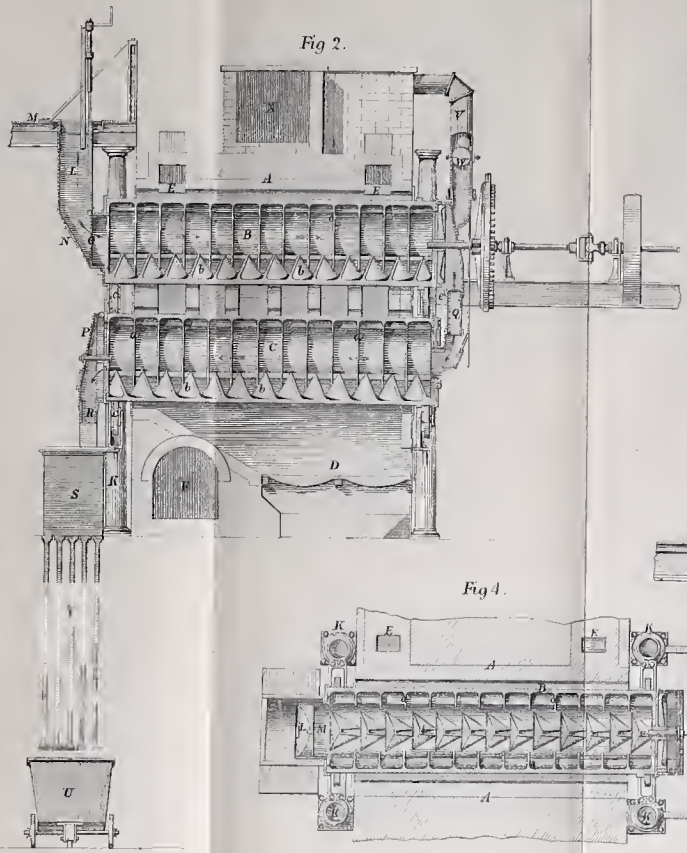


Fig 3.

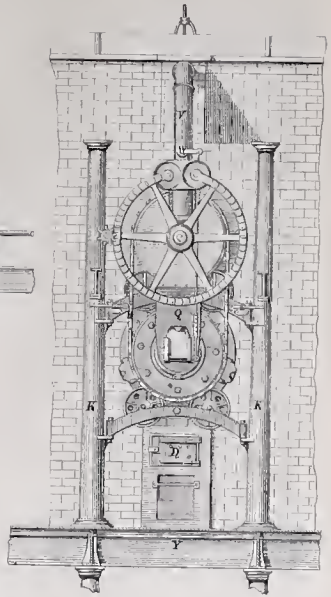
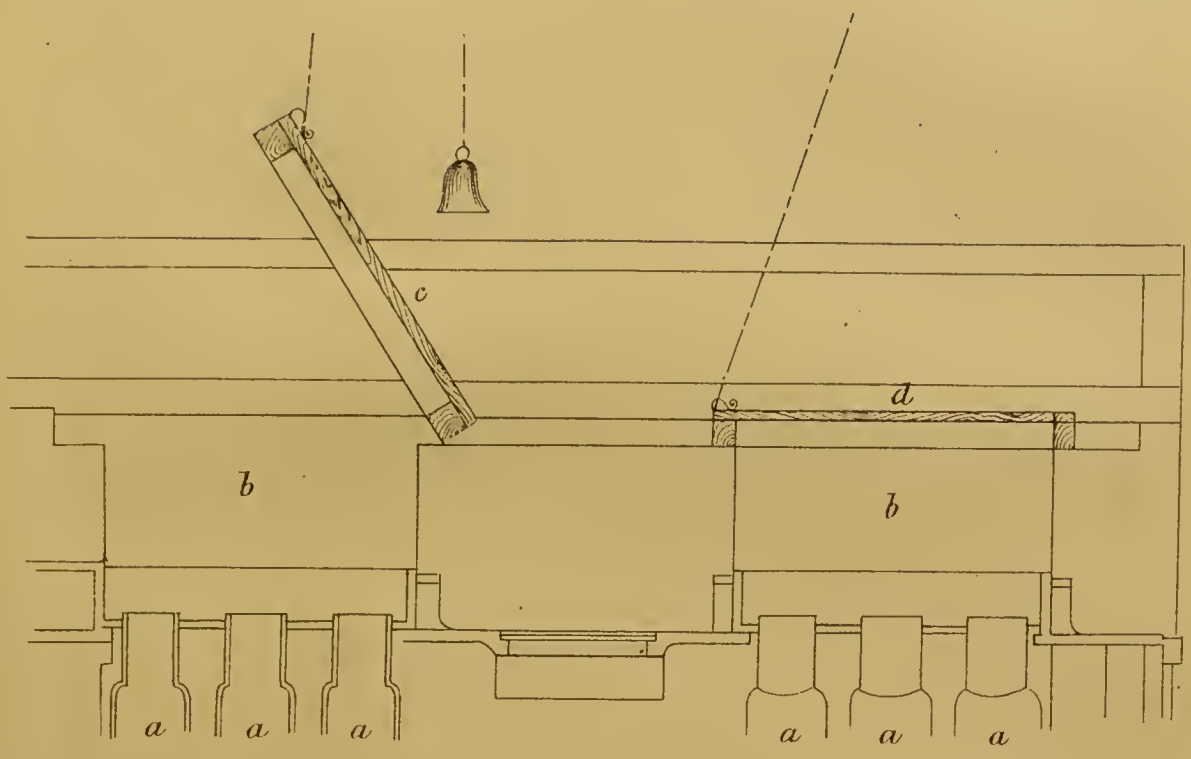


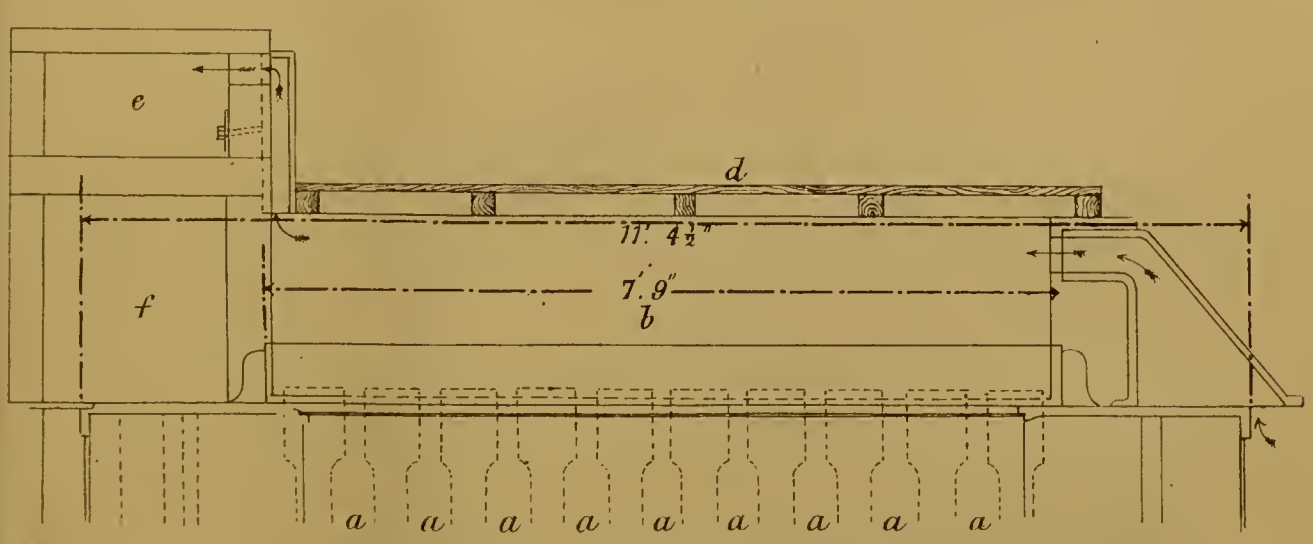
Fig 4.

DANGERFIELD, LITH 22, BEDFORD ST COVENT GARDEN

PLAN OF THE

ARRANGEMENT FOR COLLECTING VAPOURS EMANATING FROM PIPE KILNS AT DUNCAN'S SUGAR REFINERY, VICTORIA DOCKS.





a. *Upper part of pipes of kiln.*

b. *Flue into which they open above and which contains char about to be re-burned.*

c. *Wooden cover of flue raised by a pulley when the pipes are to be filled up.*

d. *Cover in its place covering in the top of the flue.*

e. *Flue for receiving vapours from b.*

f. *Flue for smoke from the kiln.*

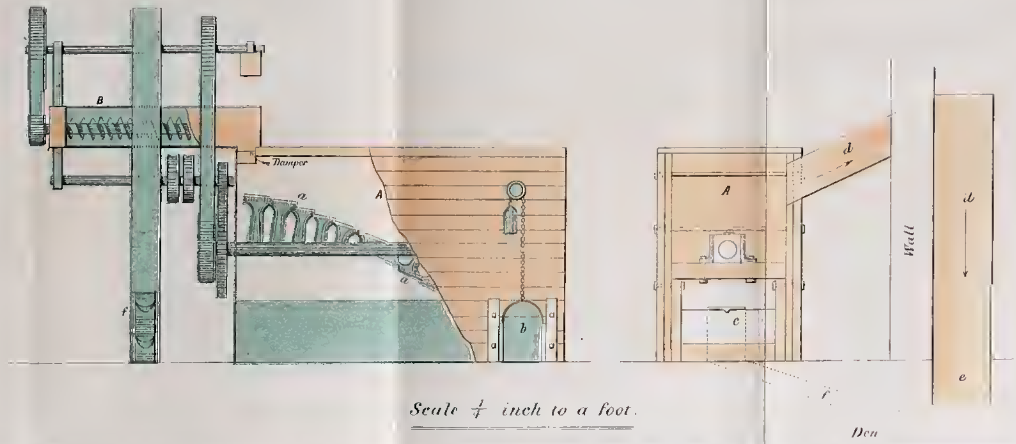
The arrows show the course of the vapours.

Plan of the Mixer

in use at

Burnard Lack and Alger's Works Plymouth.

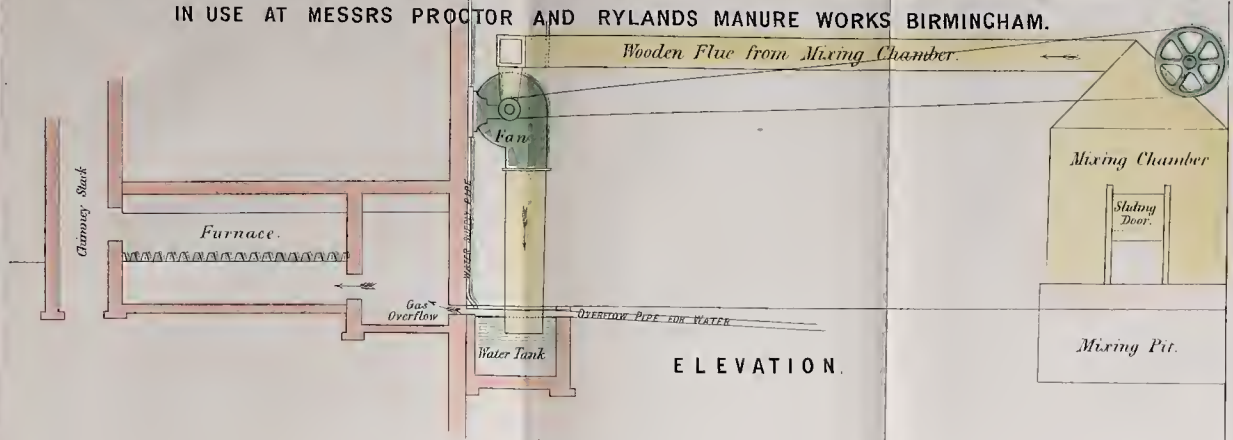
A. The Mixer - part of the interior shown.
 a the Stirrer
 b. Door for cleaning out manure shoot.
 c Damper above manure shoot to discharge contents of Mixer.
 d Flue for vapours from the Mixer leading to the interior of the den.
 e. The hot den.
 f. Shoot leading from the Mixer to the den.
B. The wooden channel fitted with an archimedian screw for the propulsion of the dry materials.
 f. Jacobs ladder by which the materials are supplied from below.

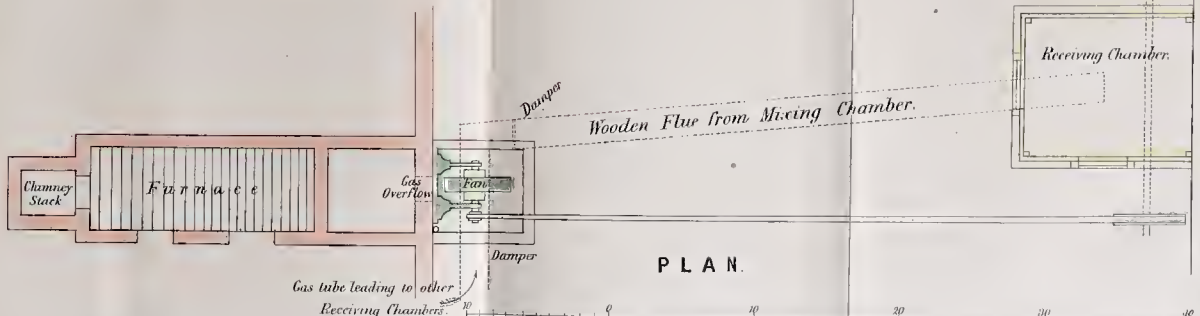


Scale 1/4 inch to a foot.

Dangerfield

PLAN OF MIXING PIT AND FLUES AND OF THE ARRANGEMENTS FOR CONDENSING AND CONSUMING VAPOURS IN USE AT MESSRS PROCTOR AND RYLANDS MANURE WORKS BIRMINGHAM.





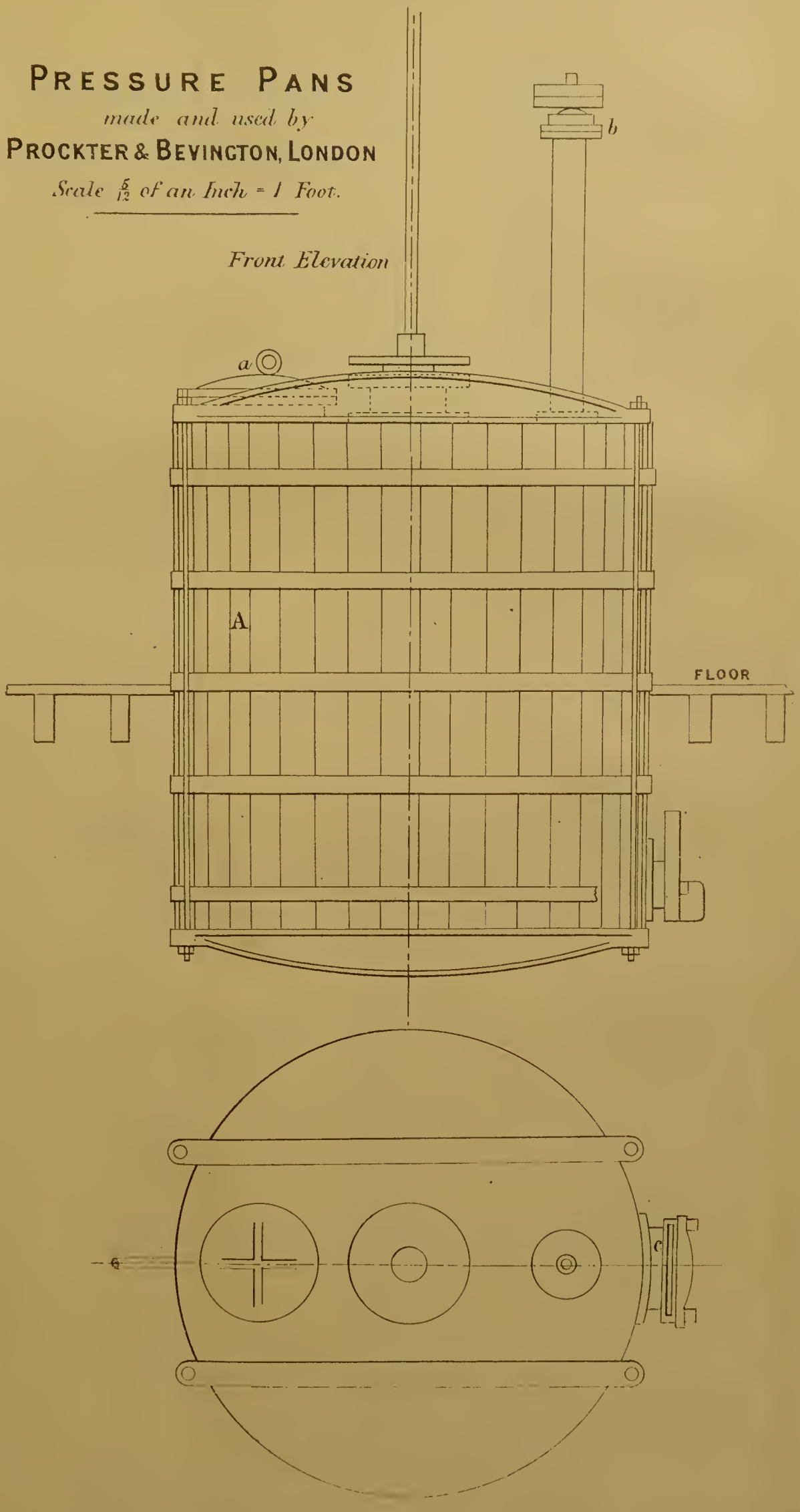
PRESSURE PANS

made and used by

PROCKTER & BEVINGTON, LONDON

Scale $\frac{6}{12}$ of an Inch = 1 Foot.

Front Elevation



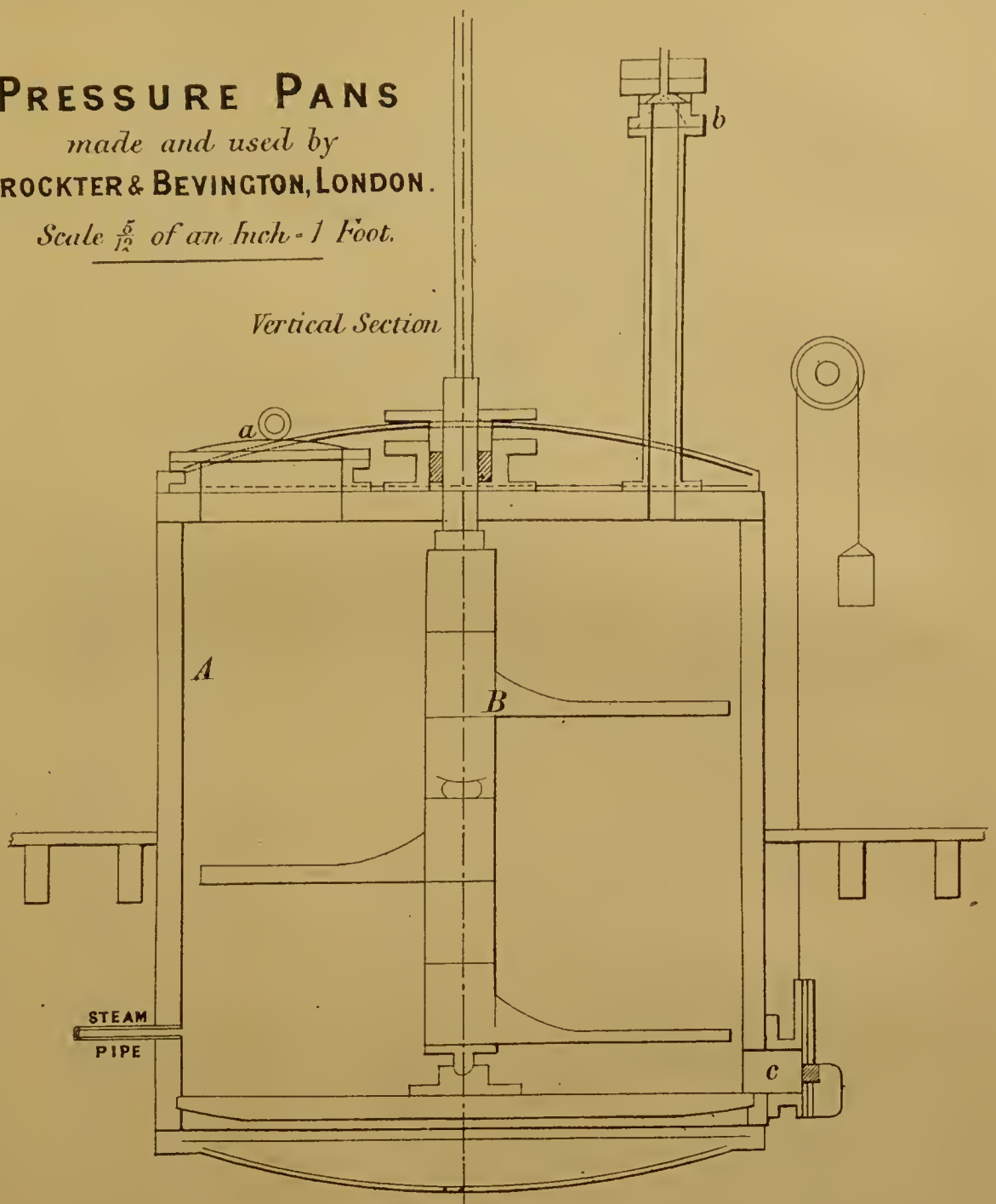
PRESSURE PANS

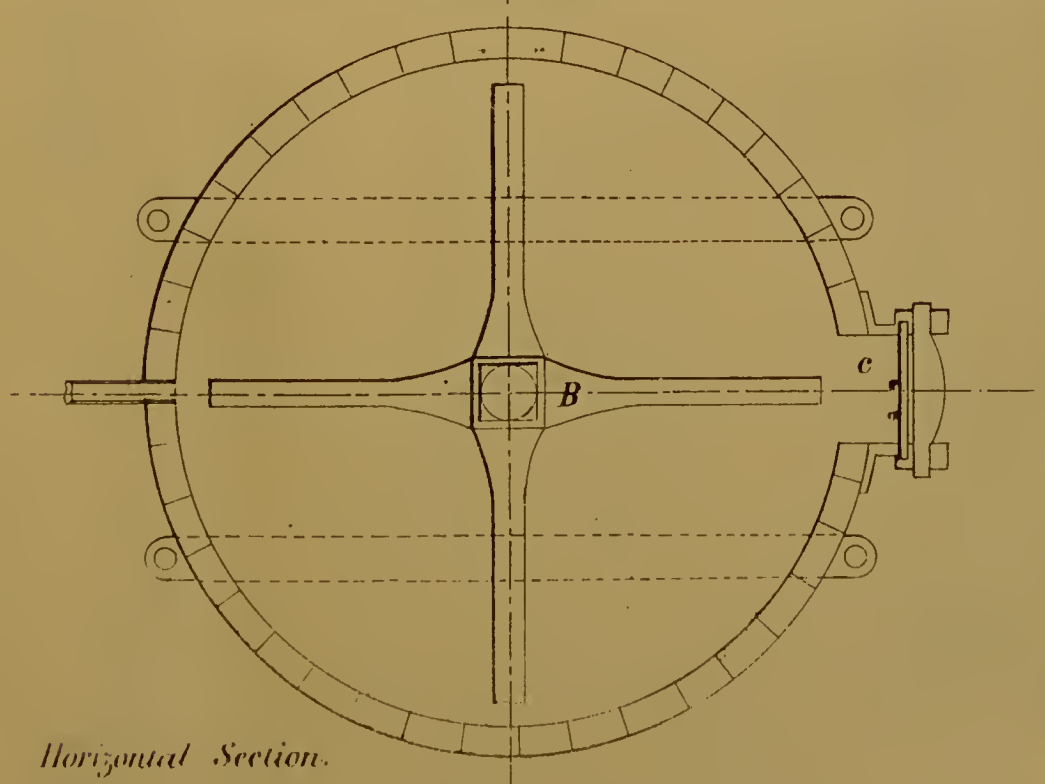
made and used by

PROCKTER & BEVINGTON, LONDON.

Scale $\frac{6}{12}$ of an Inch = 1 Foot.

Vertical Section

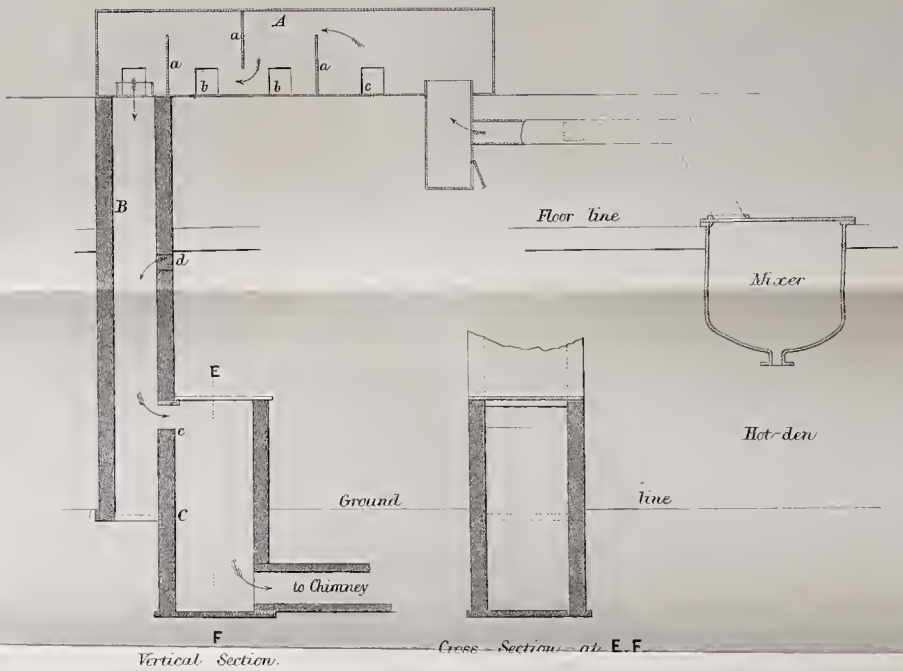


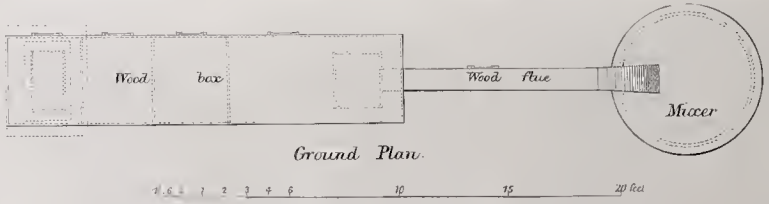


Horizontal Section.

Messrs Thomas Vickers & Sons.

Plan shewing Box, Flues &c, for catching Acid deposit from Mixer, as in use at Manchester.





A Wooden Box B Brick deposit chamber. C. Smaller similar chamber
a. Partitions springing alternately from bottom & top of box.
b Cleaning out doors
c Communication between the two brick chambers.
d. Opening from hot-den, regulated by a damper.

Plate 19.

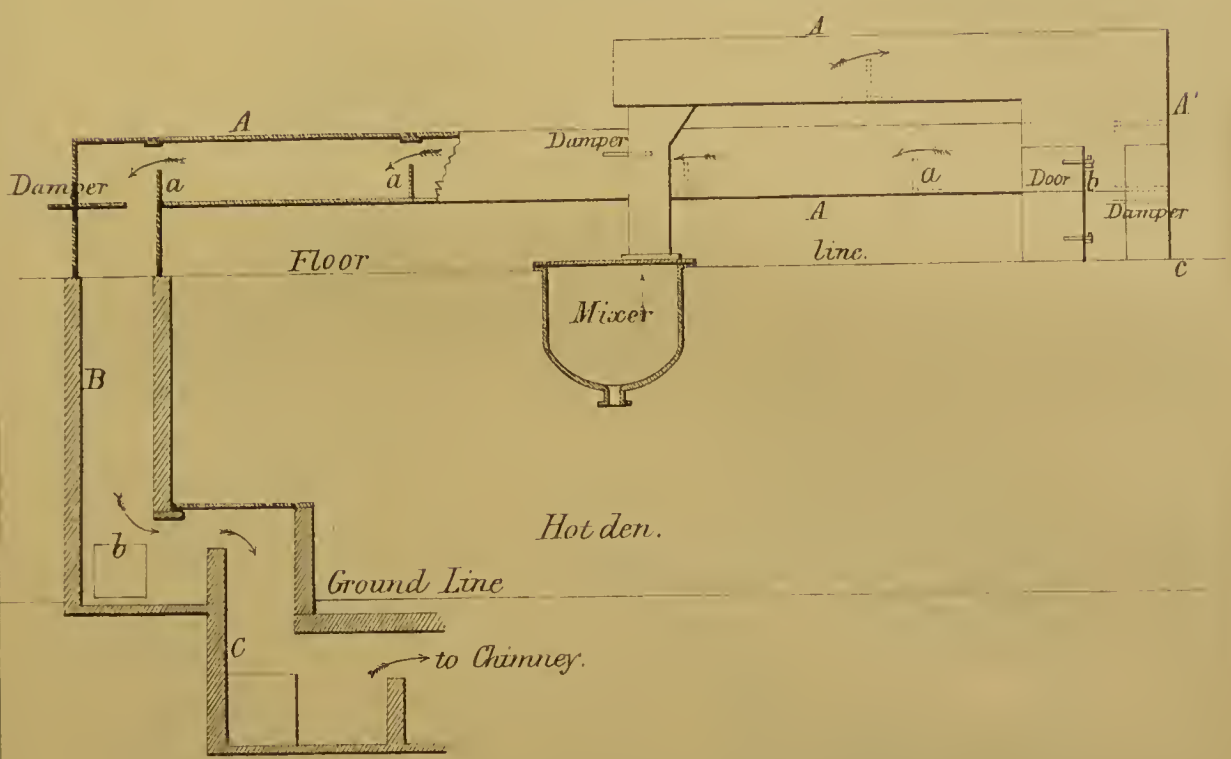
3460

Day & Son lith. 22 Hedford St Covent Garden

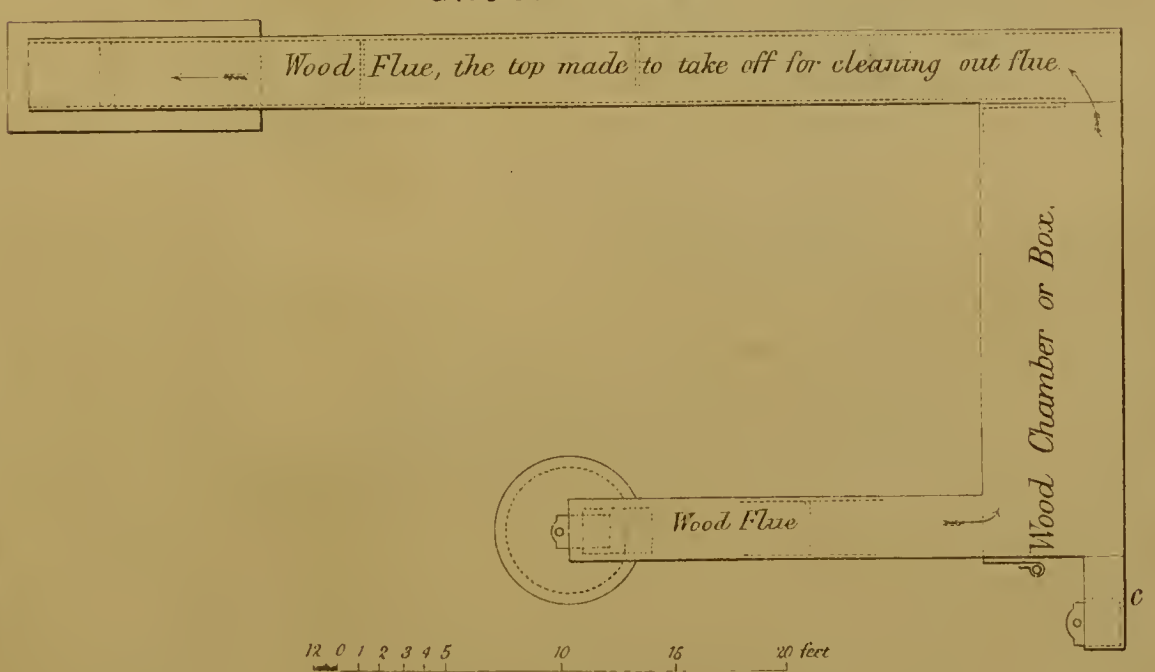
Messrs Thomas Vickers & Sons,

PLAN SHEWING BOX, FLUES &c FOR CATCHING ACID DEPOSIT FROM MIXER AS IN USE AT WIDNES.

VERTICAL SECTION & SIDE ELEVATION.



GROUND PLAN.

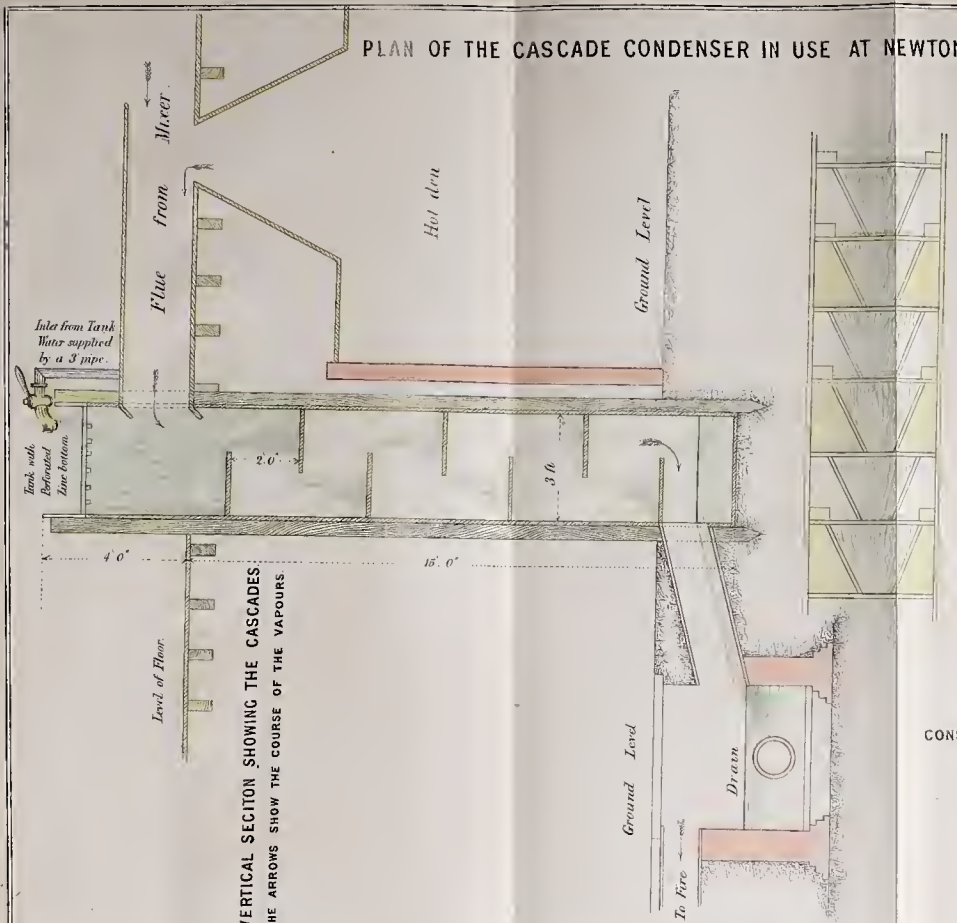


A Wooden flue enlarged at A' into a sort of Chamber.
B Brick deposit chamber. C Smaller similar chamber.
a. Partitions in flue. b Cleaning out doors. c Opening from hot den regulated by a damper.

3456

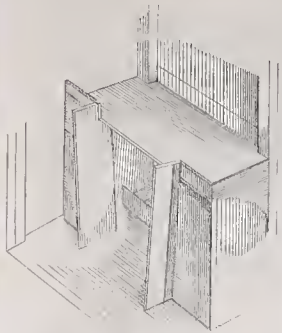
Dangerfield, Lith. 22. Bedford St. Covent Garden

PLAN OF THE CASCADE CONDENSER IN USE AT NEWTONS WORKS IN BERMONDSEY.



VERTICAL SECTION SHOWING THE CASCADES.
THE ARROWS SHOW THE COURSE OF THE VAPOURS

PLAN SHOWING THE SHAPE OF THE OPENINGS FOR THE CASCADES, AS VIEWED FROM THE FRONT OR BACK.

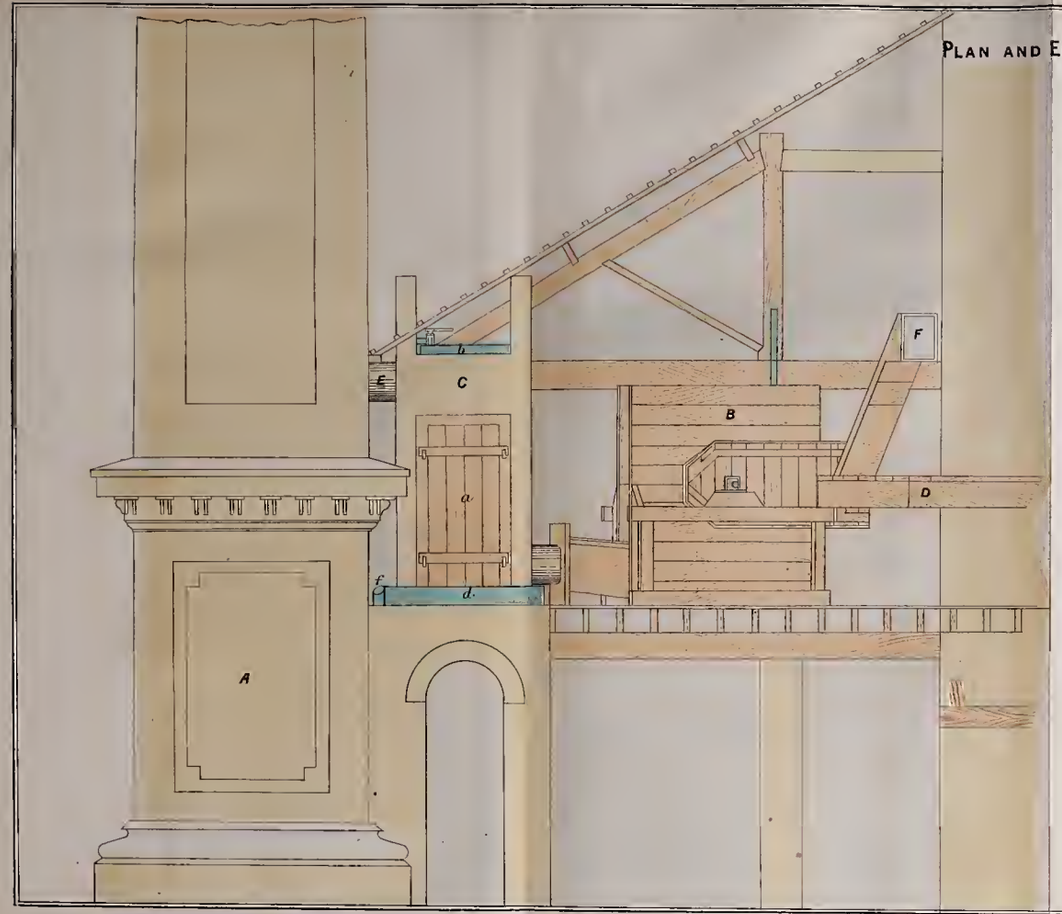


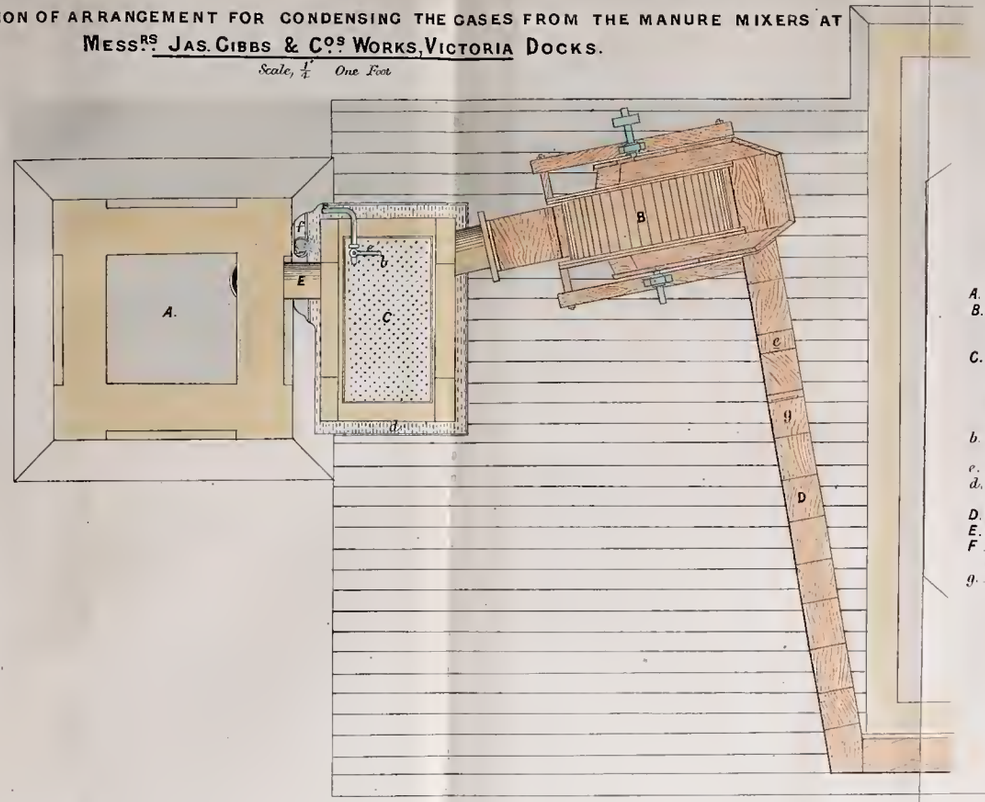
DRAWING OF THE INTERNAL CONSTRUCTION OF THE CONDENSER

Dangerfield Lith 22 Bedford St Covent Garden

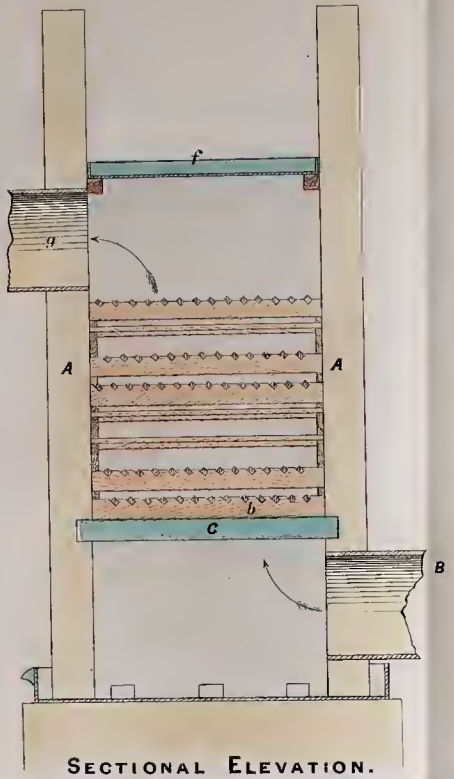
Plan and Elevation of arrangement for condensing the gases from the manure mixers at Messrs. Jas. Gibbs & Co.'s Works, Victoria Docks.

Scale, $\frac{1}{4}$ One Foot

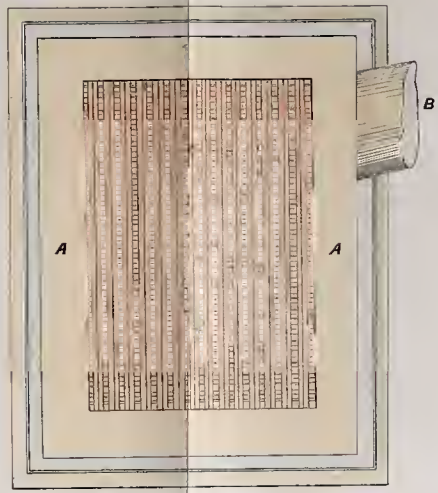




A. Chimney.
B. the Fan 6 ft diameter, 2 ft 6 ins wide, driven at 350 revolutions per minute. The cover and sides are moveable for cleaning.
C. The Condenser into which the gas is blown from the fan, this is fitted up inside with interrepting bars of wood crossing and recrossing each other at short intervals. These bars rest on a rack also of wood and can all be removed, cleaned, and replaced by removing the door *a*.
b. Perforated leaden tray through which the water falls on to the interrepting bars inside.
c. Water tap.
d. Trough or lute into which the water falls from the condenser, and overflows into the pipe *f*.
D. Wooden flue from superphosphate mixers.
E. Short flue leading from the Condenser to the Chimney.
F. Branch flue 50 yds long leading from guano mixers and entering flue from superphosphate mixers at *e*.
g. Damper.



SECTIONAL ELEVATION.



CROSS SECTION OF

GAS CONDENSER AT MESSRS. GIBBS & COS. WORKS VICTORIA DOCKS.

A.A. Brick chamber standing in a strong leaden tray or lute a. B The inlet pipe above which and built into the brickwork is a range of iron bars C encased in lead. On these bars rest the two first racks b, notches in which receive the loose bars c,c,c, c. On the top of these bars are laid packing pieces to carry the next set of racks and bars, and the same is repeated to the top, some laid lengthwise and some crosswise. f leaden tray perforated to shower on the intercepting bars beneath.

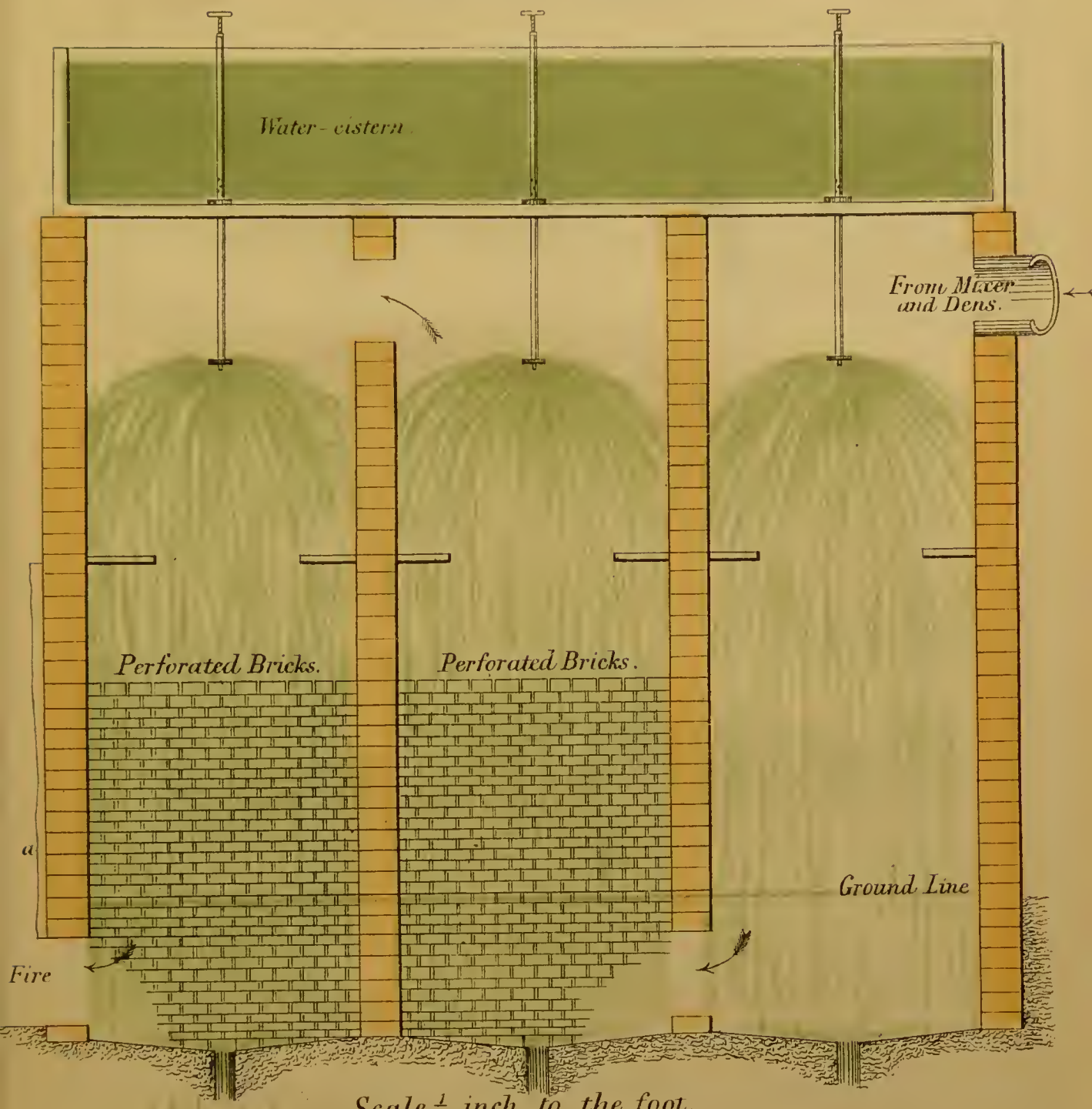
CONDENSING APPARATUS

in use at

THE PLYMOUTH CHEMICAL WORKS

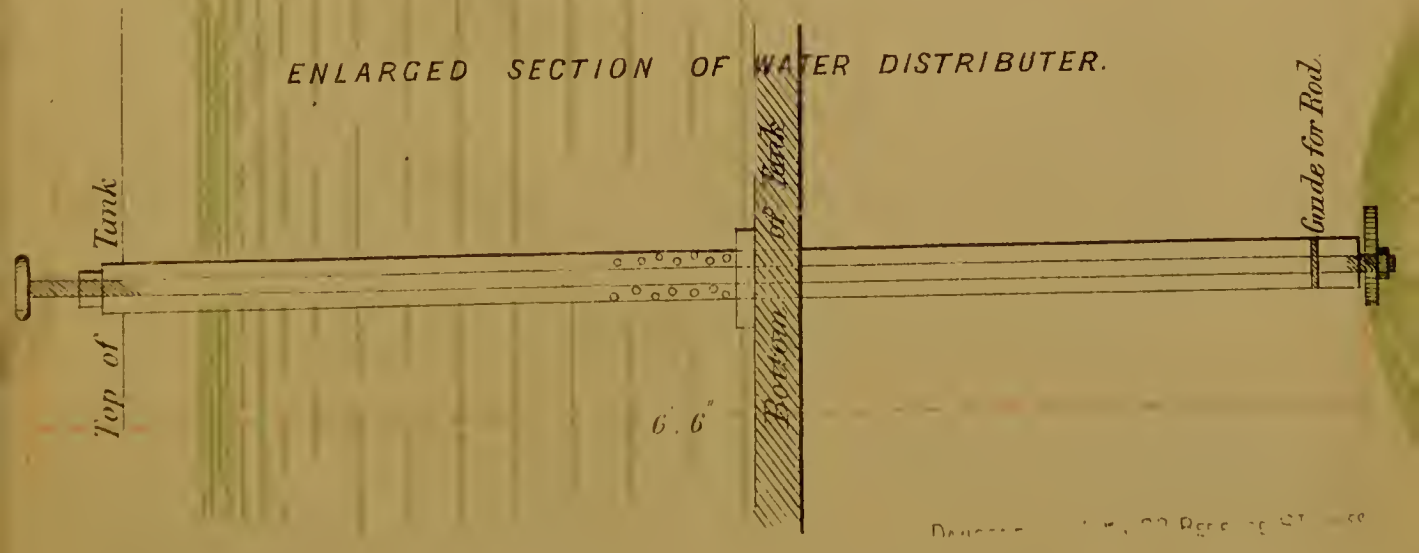
BURNARD LACK AND ALGER.

Section of Towers.



Scale $\frac{1}{4}$ inch to the foot.

ENLARGED SECTION OF WATER DISTRIBUTER.



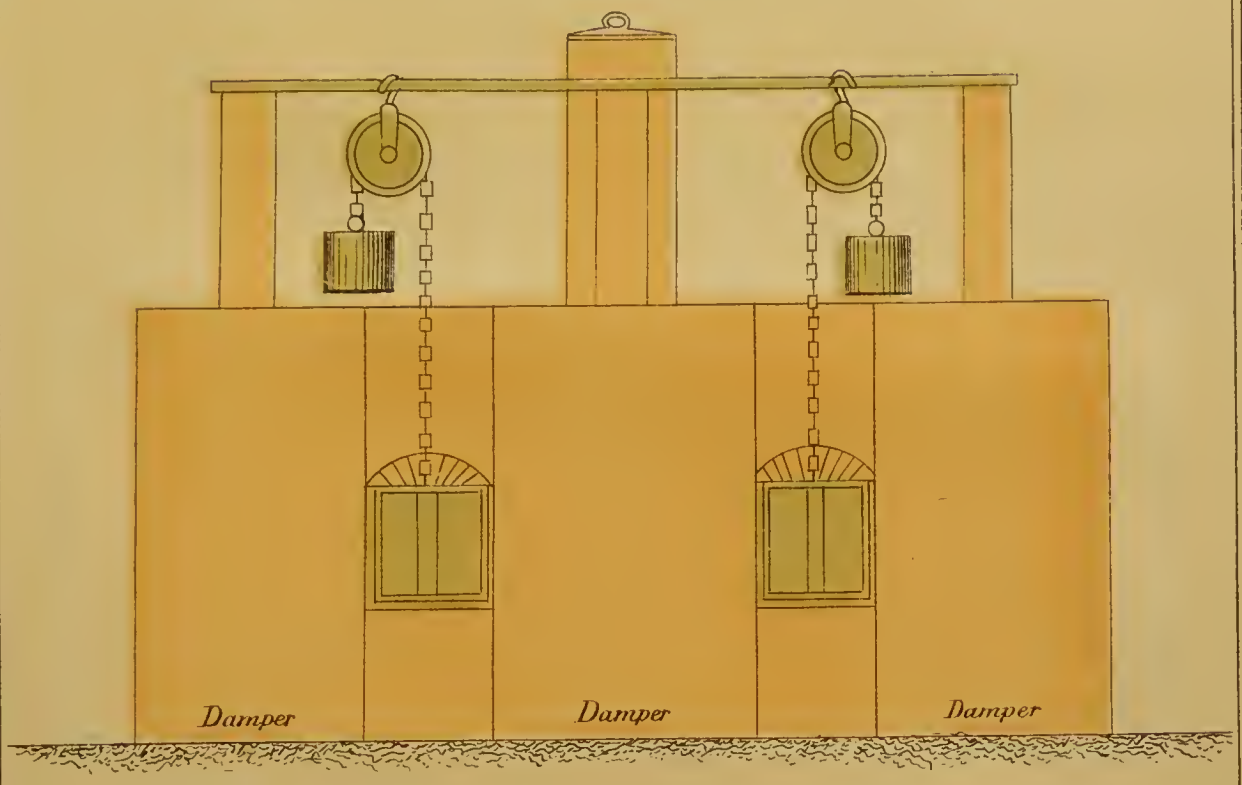
PLAN OF FURNACES FOR CONSUMING OFFENSIVE VAPOURS:

in use at

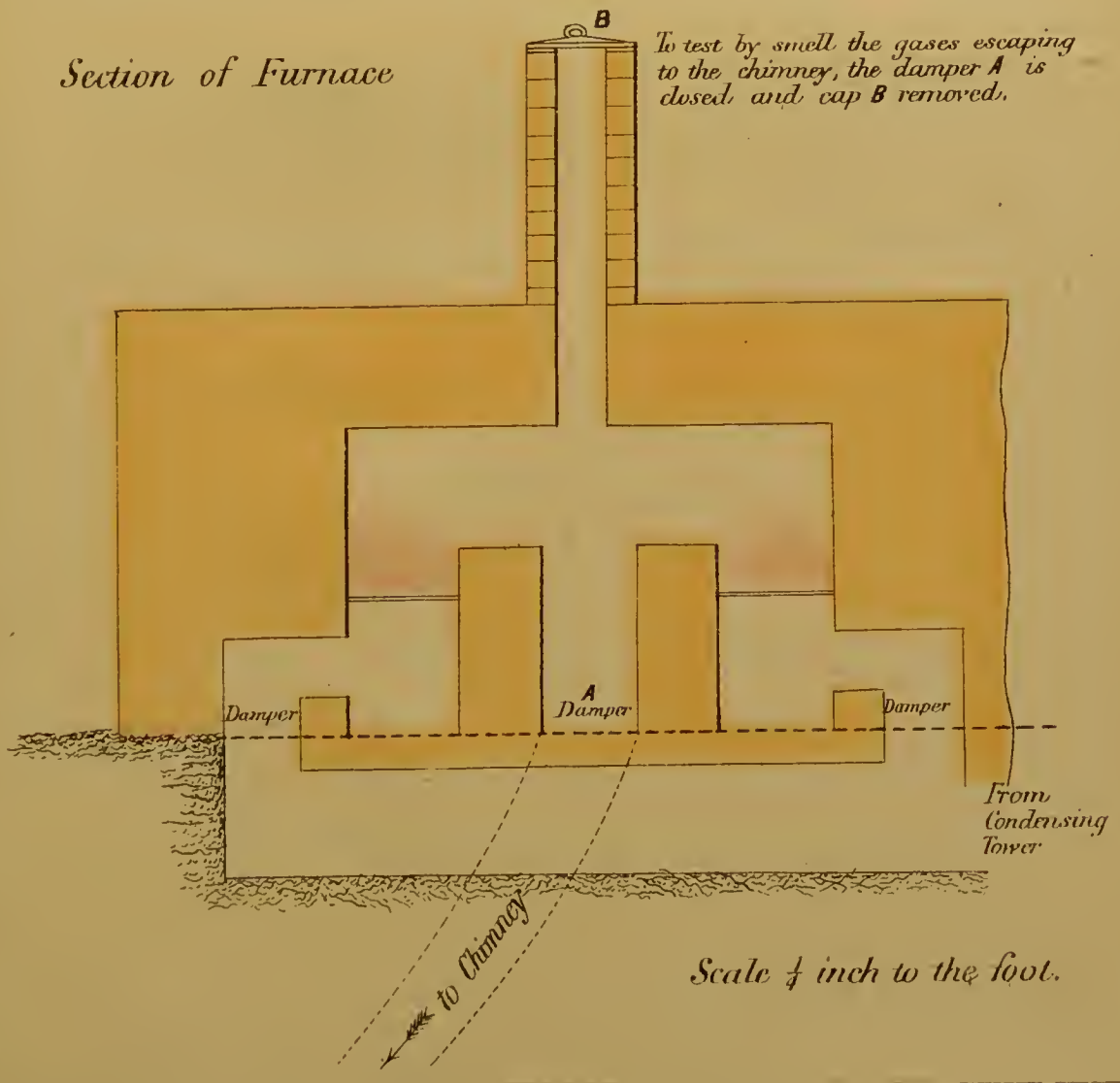
THE PLYMOUTH CHEMICAL WORKS.

BURNARD, LACK AND ALGER.

Elevation of Furnace.



Section of Furnace



Scale ¼ inch to the foot.

3456